INSTRUCTION BOOK

Type RDR-1 (X-band, 3.2 cm) AIRBORNE RADAR SYSTEM with Weather Contour Presentation

BENDIX RADIO
DIVISION OF BENDIX AVIATION CORPORATION
BALTIMORE 4, MARYLAND

I.B.732 B
Preliminary

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OR669499	RDR-1B-1 Transmitter-Receiver, AFC Section	9
OR669895	SYN-1B Synchronizer-Amplifier-Power Supply	9
OR669897	PPI-1B, 1D Indicators	9
N669556	ANT-1B, 1E Antennas	9
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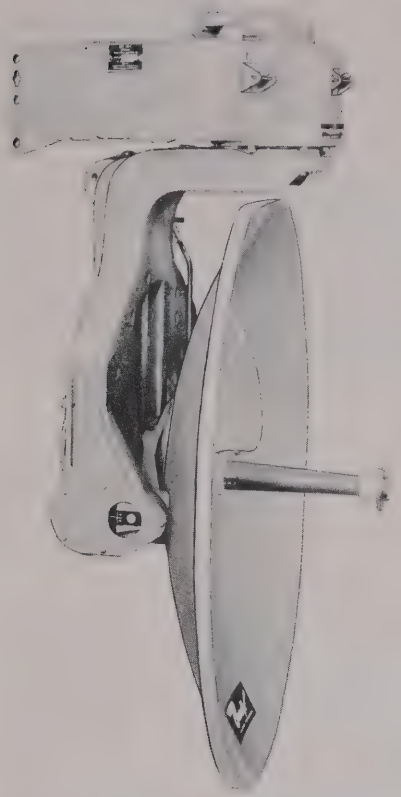
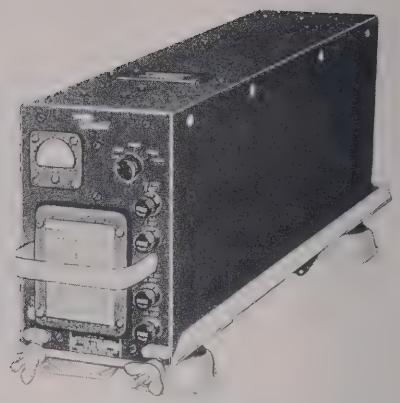
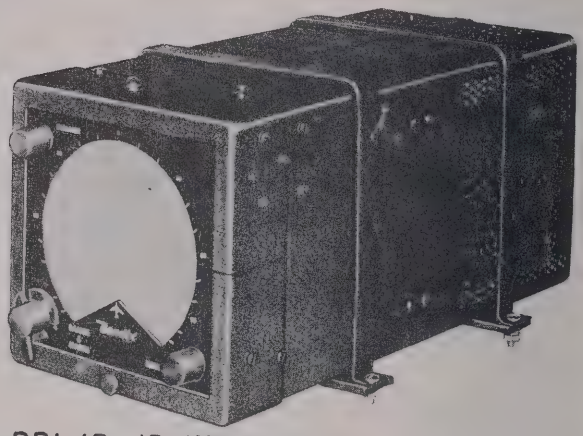


ANT-1B( ) ANTENNA



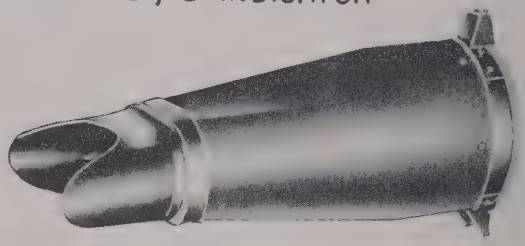
SYN-1B

SYNCHRONIZER-AMPLIFIER-POWER SUPPLY
IN SHK-1D SHOCKMOUNT

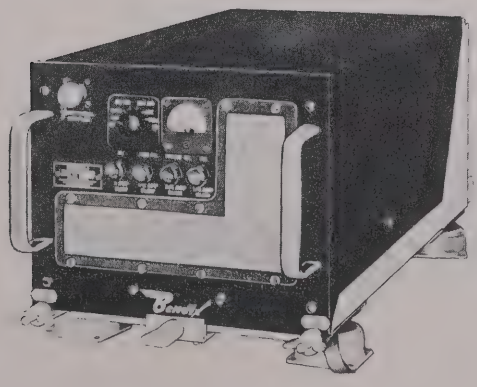


PPI-1B, 1D INDICATOR

CON-1D CONTROL



INDICATOR HOOD



RDR-1B-1
TRANSMITTER-RECEIVER
IN SHK-1A SHOCKMOUNT

FIGURE 1-1. RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM, MAJOR COMPONENTS.

SECTION I
GENERAL DESCRIPTION

1-1. GENERAL.

This instruction book (IB-732) describes the Bendix Type RDR-1 (X-Band) Airborne Radar System, its purpose, its functions and characteristics, and contains information essential to its installation and operation.

Detailed servicing and maintenance information on the several major components included in a complete RDR-1 (X-Band) Airborne Radar System is contained in the instruction books listed below.

IB-734 CON-1D CONTROL or CON-1K CONVERSION KIT
IB-735 ANT-1B and 1E ANTENNAS
IB-736 SHK-1A, 1D and 1F SHOCKMOUNTS
IB-737 RDR-1B-1 TRANSMITTER-RECEIVER
IB-739 SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY
IB-740 PPI-1B and 1D INDICATORS

These instruction books form a part of, and should be used in conjunction with, this instruction book IB-732.

The Bendix Type RDR-1 (X-Band) Airborne Radar System is a lightweight, compact, radar system designed for installation in commercial transport and executive-type aircraft. The system provides enroute weather information and storm detection up to a distance of approximately 150 nautical miles. Included in the X-band system are facilities for contour presentation of storm cells within clouds, ground mapping, terrain avoidance (advance warning of high ground), and ground-sited beacon operation. Provision is made to utilize, selectively, either a symmetrical pencil beam for search and beacon operations or a cosecant-squared (csc^2) beam to provide a fixed minimum of ground illumination at all points within the range of ground coverage for ground mapping operations.

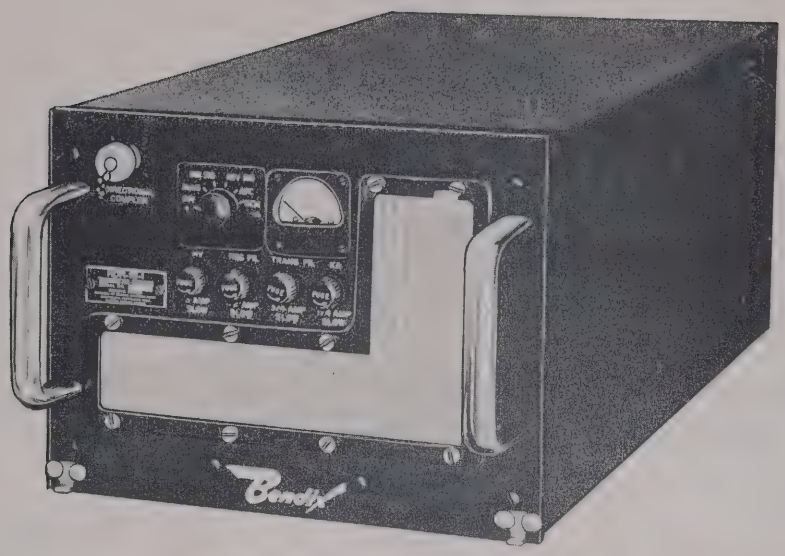


Figure 1-2. RDR-1B-1 Transmitter-Receiver, Part of RDR-1 (X-band) Airborne Radar System

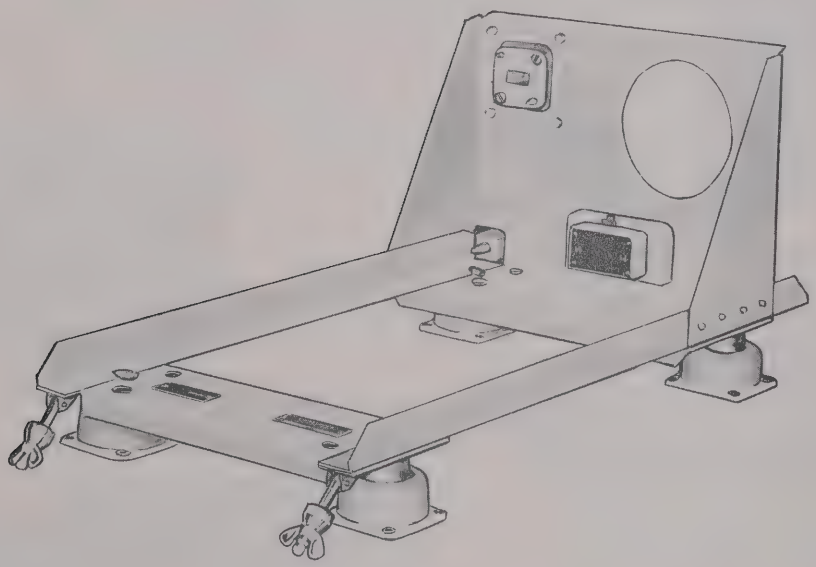


Figure 1-3. SHK-1A Shockmount, Part of RDR-1 (X-band) Airborne Radar System

The RDR-1 (X-Band) Airborne Radar System consists essentially of five basic units and two, quick-disconnect, shockmounted mounting bases, namely: The RDR-1B-1 Transmitter-Receiver (figure 1-2), the SYN-1B Synchronizer-Amplifier-Power Supply (figure 1-4), the PPI-1B Indicator or the PPI-1D Indicator (figures 1-6, 1-7), the ANT-1B Antenna (figure 1-8) or the ANT-1E Antenna, and the CON-1D Control (figure 1-9). The mounting bases available with the system are the SHK-1A Shockmount (figure 1 3) for the RDR-1B-1 Transmitter-Receiver, and the SHK-1D Shockmount (figure 1-5) or the SHK-1F Shockmount (figure 7-1) for the SYN-1B Synchronizer-Amplifier-Power Supply.

The effective use of lightweight structural materials, silicon rectifiers, encapsulated transformers, and, where practical, miniaturized components of reliable, high performance standards, has resulted in a system, including one indicator, but less interconnecting cables and waveguide and antenna mounting block, weighing only 110 pounds.

Transmitting in the range from 9345 to 9405 megacycles per second, and generating a peak pulse power of 40 kw minimum, the system presents the minimum primary power demand consistent with the maximum performance and reliability required by the application. Reception of echo signals is accomplished at the transmitted frequency, while reception of beacon response signals is accomplished at 9310 megacycles per second, which is the fixed transmitting frequency of all X-band ground-sited beacons.

The RDR-1 Airborne Radar System provides for the use of one or two indicators. (See the system interconnecting wiring diagram, figure 3-4.) When two indicators are used, the operator of each has independent control of range selection, display brilliance, and illumination of the azimuth calibrations on the indicator overlay.

1-2. FUNCTION OF EQUIPMENT.

The RDR-1 (X-Band) Airborne Radar System has been developed to provide the pilots of commercial transport and executive-type aircraft with a practical, dependable means to quickly evaluate enroute weather conditions. Warned by means of radar-echo displays, the pilot is able to select a route through a

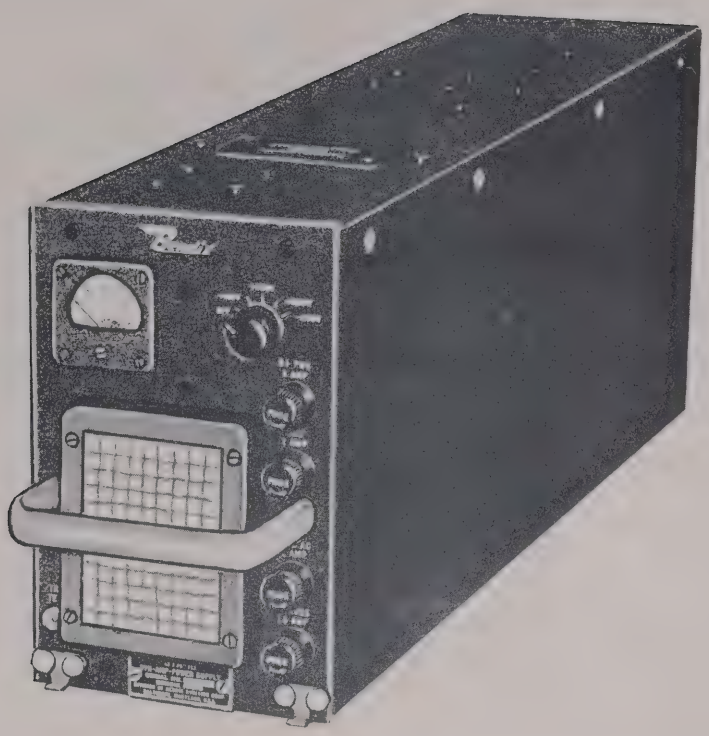


Figure 1-4. SYN-1B Synchronizer-Amplifier-Power Supply, **Part of** RDR-1 Airborne Radar System

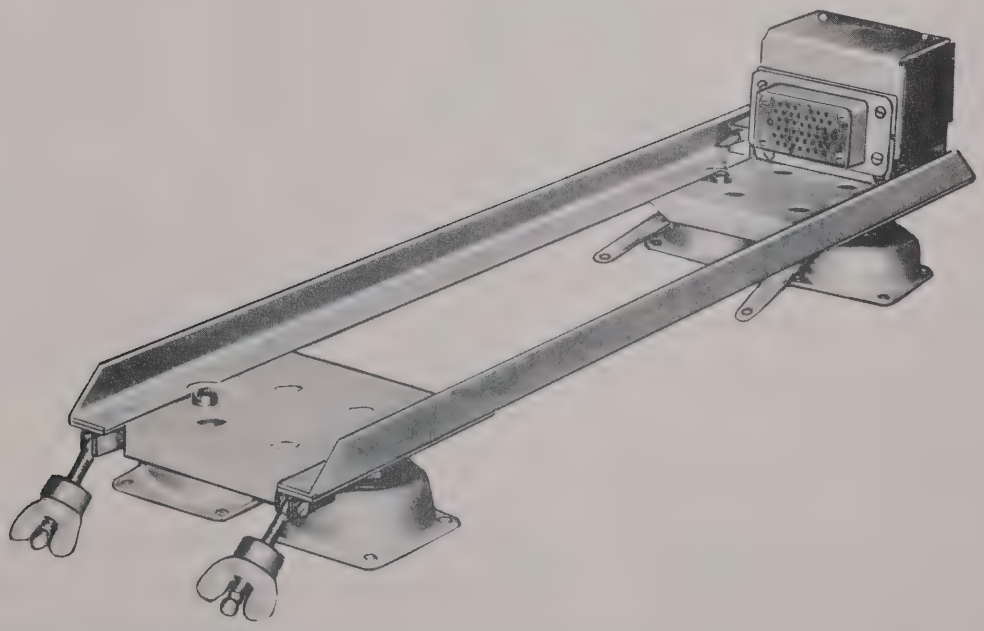


Figure 1-5. SHK-1D Shockmount, Part of RDR-1 Airborne Radar **System**

storm front, avoiding the turbulence associated with thunderstorms, without serious reduction in speed and with much greater safety and passenger comfort.

One of the salient features of this equipment lies in the special rainfall-rate contour circuitry designed into it. A new technique of PPI-scope presentations, known as ISO-ECHO contours, presents a visual pattern of rainfall gradients, within thunderstorm clouds, indicating the areas of turbulence to be avoided. The contour circuit, when energized, alters the normal radar presentation to display areas of high rainfall rate as black holes in the signal return. The position, intensity, and extent of the storm cell or cells within clouds is immediately apparent, and by avoiding these areas a smooth passage through the storm front will be effected.

A series of photographs showing the PPI presentation of storm clouds, with and without the use of contour circuitry, is included in section IV. (See figure 4-2, displays A through P.)

In addition to its primary function of WEATHER MAPPING, the RDR-1 (X-Band) Airborne Radar System will provide a visual indication of the position of cities, landmarks, shorelines, ships, mountains and other terrain features, in range, and azimuth bearing with respect to the heading of the aircraft, up to a distance of approximately 150 nautical miles within the scan limits of the antenna. (See figure 4-3.)

Facilities for GROUND MAPPING (with cosecant-squared beam), GROUND BEACON OPERATION, and TERRAIN AVOIDANCE are present in this equipment and these functions supplement the WEATHER MAPPING feature to provide multiple and reliable aids to air navigation even during darkness and overcast when normal vision is dangerously restricted.

1-3. EQUIPMENT SUPPLIED.

The equipment supplied as an RDR-1 (X-Band) Airborne Radar System is listed in table 1-1, together with weights and dimensions of the individual units.

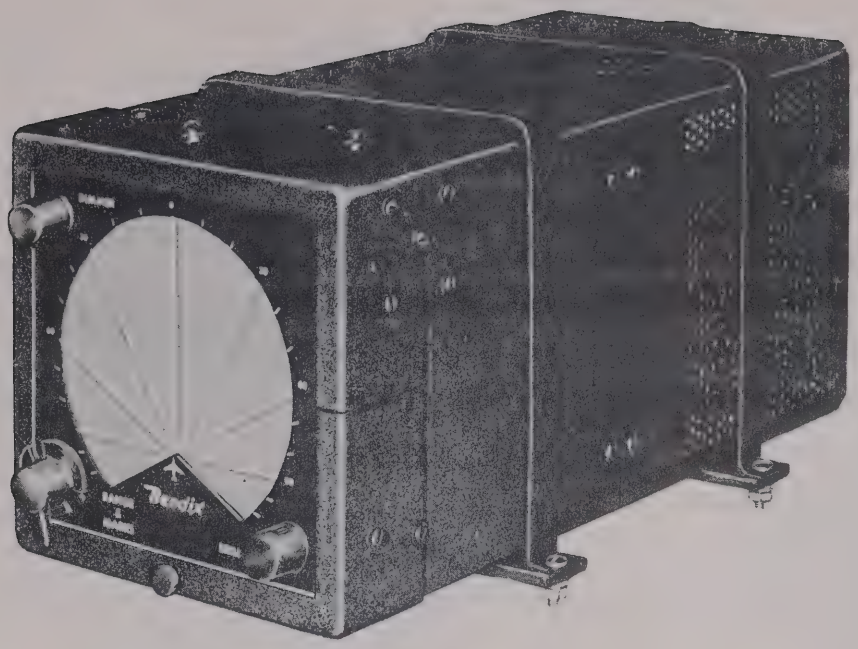


Figure 1-6. PPI-1B or 1D Indicator (Less Viewing Hood), Part of RDR-1 Airborne Radar System

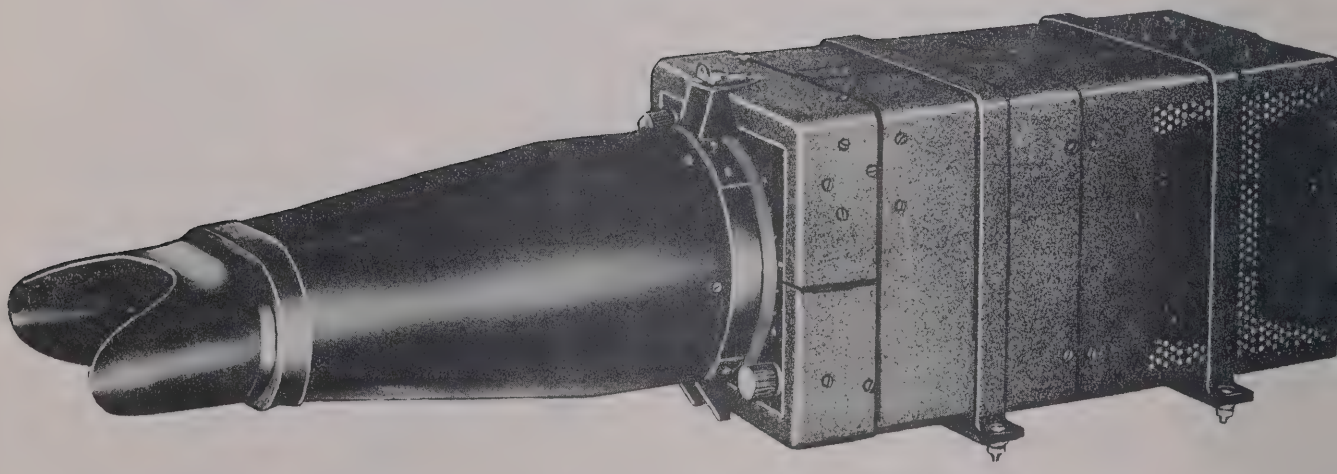


Figure 1-7. PPI-1B or 1D Indicator (With Viewing Hood Attached), Part of RDR-1 Airborne Radar System

TABLE 1-1. EQUIPMENT SUPPLIED, RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM

QTY	TYPE	NAME OF UNIT	OVER-ALL DIMENSIONS (INCHES)	WEIGHT (POUNDS)
1	RDR-1B-1	Transmitter-Receiver	10.12 wide 7.62 high 22.48 deep	41.0
1	SYN-1B	Synchronizer-Amplifier-Power Supply	4.89 wide 7.94 high 22.48 deep	21.0
1	CON-1D	Control	5.75 wide 3.375 high 3.86 deep	2.25
1	ANT-1B or ANT-1E	Antenna	See outline dimensional dwg, figure 3-13.	23.75
1 or 2	PPI-1B or PPI-1D	Indicator, including viewing hood	6.31 wide 6.31 high 12.75 deep* *(without viewing hood)	14.1
1	SHK-1A	Shockmount (for RDR-1B-1 Transmitter-Receiver)	See outline dimensional dwg, figure 3-7.	4.25
1	SHK-1D **	Shockmount (for SYN-1B Synchronizer-Amplifier Power Supply)	See outline dimensional dwg, figure 3-9.	3.25

** Refer to section VII for other available shockmounts.

1-4. EQUIPMENT REQUIRED BUT NOT SUPPLIED.

Equipment essential for the installation of the RDR-1 (X-Band) Airborne Radar System, but which is not supplied, is listed in table 1-2.

Power requirements for the operation of the system are listed in table 1-4.

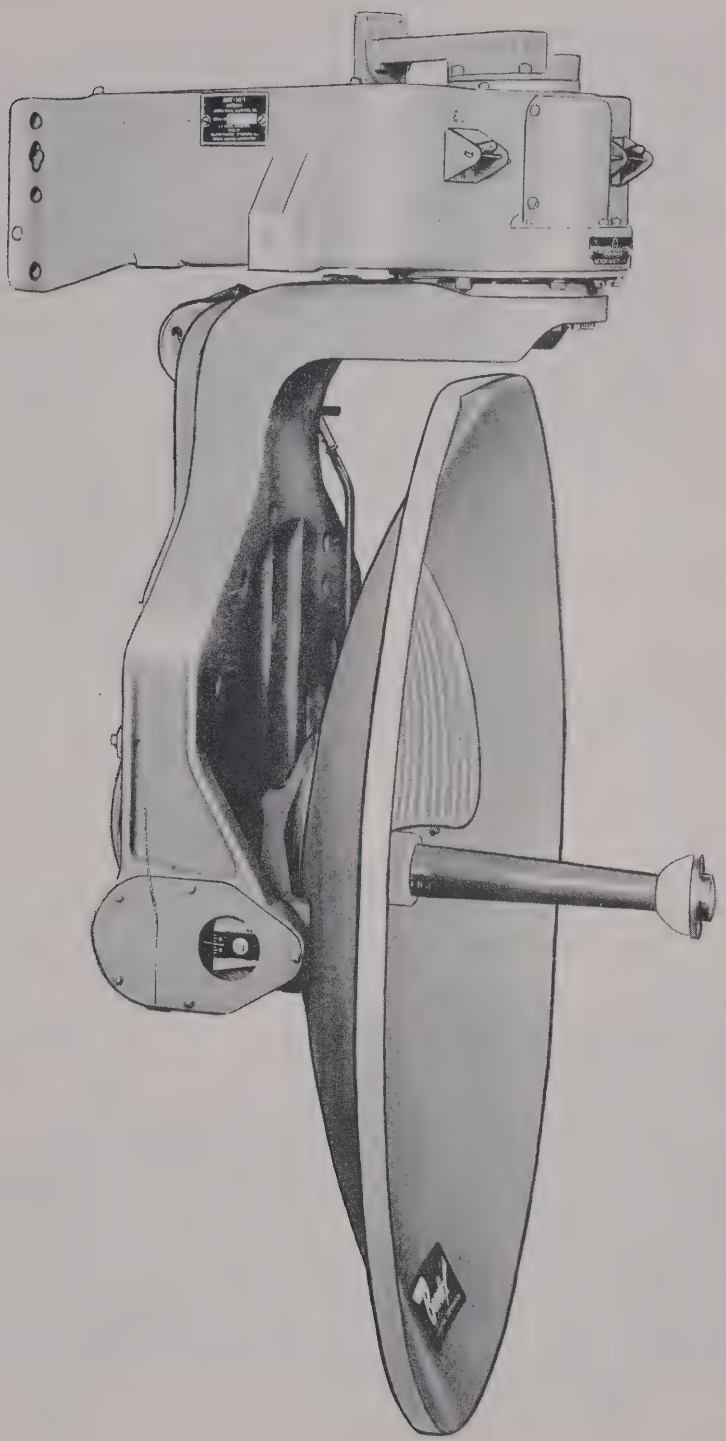


Figure 1-8. ANT-1B Antenna, Part of RDR-1 (X-band) Airborne Radar System

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED
(CABLES, CONNECTORS, WAVEGUIDE, ABSORPTION SCREEN)

CABLE AND CABLE COMPONENTS (See figure 3-3.)										
CABLE	JACK		NUMBER OF LEADS, WIRE SIZE AND TYPE							
	NO.	COMMERCIAL TYPE	#16	#18	#20	#22	#22 SS	#22 SP	#22 3WS	COAX RG-59/U
To RDR-1B-1 Transmitter-Receiv										
A	J6301	DPD-A 32C2-33S-L (Supplied)	2	1	2	9	1	1	-	2
To SYN-1B Synchronizer-Amplifier-Power Supply										
B	J6401	DPD-45-33S-L (Supplied)	1	1	7	10	3	8	-	-
To CON-1D Control										
C	J6501	DC-37-S	-	2	-	7	-	2	1	-
To PPI-1( ) Indicator No. 1										
D	J6101	PPI-1B,FK-37-21C 5/8 PPI-1D,FK-37-23-1B	-	-	2	8	1	1	1	-
	J6102**	PPI-1D, UG-260/U								1
To PPI-1( ) Indicator No. 2										
E*	J6103	PPI-1B,FK-37-21C 5/8 PPI-1D,FK-37-23-1B	-	-	2	8	1	1	1	-
	J6104**	PPI-1D,UG-260/U								1
To ANT-1( ) Antenna										
F	J6201	AN-3106E-36-7S (Straight) AN-3108-36-7S (90-degree)	-	-	2	5	-	3	2	-
G	None	---------	-	-	-	-	-	2	-	-
X	Note: Use as needed between aircraft junction strips and primary power sources.		3	2	6	1	-	-	-	-

NOTE: All wires stranded. SS = Single Shielded. SP = Shielded Pair.
3WS = Three-Wire Shielded

* Cable E necessary only if two indicators are used.
** Not used on Type PPI-1B Indicators

-continued-

Figure 1-9. CON-1D Control, Part of RDR-1 (X-band) Airborne Radar System

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED (CABLES, CONNECTORS, WAVEGUIDE, ABSORPTION SCREEN) (continued)

WAVEGUIDE	
TYPE	QUANTITY AND PURPOSE
(Rigid) RG-67/U, RG-68 or Ridge* Waveguide Type ARA-136	As needed. Transmission line between RDR-1B-1 Transmitter-Receiver and ANT-1B Antenna. Keep total run to 30 feet or less to avoid excessive attenuation. Where long waveguide run is required, the use of type RG-68, large "X" band, in place of RG-67/U will reduce attenuation by about one-third. The Type ARA-136 is RIDGE WAVEGUIDE for operation on either "X" band or "C" band. When other than type RG-67/U rigid waveguide is used, proper transitions and connectors must be employed. the type ARA-136 RIDGE WAVEGUIDE is manufactured by AIRTRON INC. *
(Flexible) RG-67/U, RG-68 or Ridge* Waveguide Type ARA-136	As needed.
" * " Refer to paragraph 3-3e(2).	

ABSORPTION SCREEN		
TYPE	DESCRIPTION	QUANTITY
T-XJ-1	Mat type, approx 5/32 in. thick.	As needed.
NOTE: Available from McMillan Supply Co., Ipswich, Mass.		

1-5. SUMMARY OF SPECIFICATIONS.

The following is a summary of the electrical, mechanical, and physical characteristics of the RDR-1 (X-Band) Airborne Radar System.

Transmitting frequency	9375 ±30 megacycles per second
Wavelength	3.2 cm
Receiving frequency	
Search operation	Same as transmitted frequency
Beacon operation	Same as response frequency (9310 megacycles per second)
Pulse width	
Search operation	1.5 microseconds
Beacon operation	2.25 microseconds
Power output	40 kw peak minimum
Type of receiver	Superheterodyne
Type of reception	Pulse
Intermediate frequency	30 megacycles per second
I-f bandwidth	1 mc at 3-db points, 30 megacycles per second center frequency
Local oscillator frequency	
Search operation	30 megacycles per second below transmitted frequency
Beacon operation	9280 megacycles per second (30 megacycles per second below response frequency)
Antenna-scan angle	360 degrees
Antenna-tilt limits	±15 degrees from horizontal
Antenna stability	Line of sight ±20 degrees minimum at zero-degree tilt
Antenna speed	15 rpm ±3 rpm

Beam width	
Pencil beam	Depends on reflector diameter (approx 3.8 degrees when 22-inch reflector is used)
Cosecant-squared beam	Approximately 3.8 degrees in horizontal plane (for 22-inch reflector). Radiated as cosecant-squared beam in vertical plane.
Polarization	
Pencil beam	Horizontal
Cosecant squared (MAP) beam	Vertical
Radiator	Circular ring feed
Sweep ranges	20-50-150 nautical miles
Range markers	5-10-25 nautical miles
System designed for operation under ambient conditions of:	
Temperature	$-40^{\circ}C$ ($-40^{\circ}F$) to $+55^{\circ}C$ ($+131^{\circ}F$)
Humidity	10 per cent to 95 per cent at $50^{\circ}C$ ($+122^{\circ}F$)
Pressures (system except antenna)	Sea level to 16,000 feet
Antenna	Sea level to 40,000 feet
Primary power requirements	Refer to table 1-4
Tube complement	Refer to table 1-3
Unit weights and dimensions	Refer to table 1-1

TABLE 1-3. TUBE COMPLEMENT FOR RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM (INCLUDING ELECTRON TUBES, GERMANIUM DIODES, NONMETALLIC RECTIFIERS, FUSES AND PANEL LAMPS)

ELECTRON TUBES			
TUBE TYPE	DESCRIPTION	QUANTITY	
1B63A	GAS TR tube	1	
2J55	Magnetron	1	
2K25	Klystron	2	
3B24WA	Half-wave HV rectifier	1	
5AHP7A	Cathode-ray indicator tube	1	1*
5651	Glow discharge diode, voltage regulator	2	
5654	Sharp cut-off pentode (special 6AK5)	7	
5670	High-frequency dual triode (special 2C51)	6	2*
5725	Dual-control r-f pentode (special 6AS6)	3	
5726	Dual diode (special 6AL5)	1	
5727	Thyratron (special 2D21)	1	
5751	High-mu dual triode (special 12AX7)	4	
5814	Medium-mu triode (special 12AU7)	6	2*
6005	Beam power amplifier (special 6AQ5W)	5	1*
6080	Low-mu amplifier, dual triode (special 6AS7G)	2	
6136	Sharp cut-off r-f pentode (special 6AU6)	3	
6201	High frequency dual triode (special 12AT7)	6	2*
6203	Full-wave high-vacuum rectifier	1	
6268/AX9911	Thyratron switch	1	
6396	Gas ATR switch	2	
	Total	56	8*

NOTE

Quantity shown is for system using one indicator. For systems using two indicators, add quantity of tubes marked " * ".

SPARK GAP		
BENDIX DRAWING NUMBER	DESCRIPTION	QUANTITY
C678216-2	Arrestor, electrical surge	1

TABLE 1-3. TUBE COMPLEMENT FOR RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM (INCLUDING ELECTRON TUBES, GERMANIUM DIODES, NONMETALLIC RECTIFIERS, FUSES AND PANEL LAMPS) (continued)

TYPE	DESCRIPTION	QUANTITY	
1N23C	Silicon diode	4	
1N220	Silicon diode	7	7*
BENDIX DWG NUMBER			
C221944-1	Germanium diode	2	
C291625-2	Selenium diode	1	
L291649-1	Selenium diode	1	
L291651-29 or L291651-4	Silicon diode	4	
L291652-1 or L291651-33	Silicon diode (finned) / Silicon diode (non-finned)	8	
	Total	27	7*

NOTE

Quantity shown is for system using one indicator. For systems using two indicators, add quantity marked " *".

FUSES

TYPE	RATING	QUANTITY
3AG, slo-blo	0.25 amperes	1
3AG, slo-blo	0.50 amperes	1
3AG, slo-blo	0.75 amperes	1
3AG	1.50 amperes	1
3AG	2.00 amperes	2
3AG, slo-blo	3.00 amperes	1
3AG	3.00 amperes	1
	Total	8

PANEL LAMPS

BENDIX DWG NUMBER	DESCRIPTION	QUANTITY	
C221312-4	28 volts, 40 milliamperes, incandescent, T-1 3/4	6	4*

NOTE

Quantity shown is for system using one indicator. For systems using two indicators, add quantity marked " * ".

1-6. INPUT POWER REQUIREMENTS.

The input power required by the RDR-1 (X-Band) Airborne Radar System includes a-c power, d-c power, and the roll and pitch output voltages from the aircraft's vertical gyro.

The d-c power required is 28 volts at 0.87 ampere, maximum, for relay operation and panel lamps.

Roll and pitch output voltages, from the aircraft's vertical gyro, are required by the stabilization system of the radar.

The a-c power required may be supplied by one, or a combination of primary power sources which satisfy the requirements as outlined in table 1-4.

TABLE 1-4. PRIMARY POWER REQUIREMENTS

LOAD NO.	INPUT* CONNECTIONS	TYPE OF POWER REQUIRED	DEMAND** -OPERATION- (SEARCH)	(BEACON)	COMMENTS
1	A to I	115V ±10% 300-1000 cps	175 va	185 va	Must be connected to a grounded phase.
2	B to I	115V ±10% 300-1000 cps	95 va	95 va	Must be connected to a grounded phase.
3	C to D	115V ±10% 300-1000 cps	300 va	360 va	Need not be a grounded phase, it can parallel any other load, numbers 1 to 6.
4	E to I	115V ±5% 400 ±5% cps	45 va	45 va	Must be connected to phase used as reference for vertical gyro
5	F to I	115V ±10% 400 ±5% cps	110 va	110 va	May be connected to either grounded phase.
6	G to H	115V ±10% 400 ±5% cps	45 va	45 va	Need not be a grounded phase. If desired, it can parallel any 400 ±5% cps load, number 4 or 5.
7	J to L	28V dc	0.87 amps max combined		Lamp supply. May be connected to any 28-volt d-c source capable of supplying maximum demand.
8	K to L	28V dc			Relay power

VERTICAL GYRO ROLL AND PITCH OUTPUT VOLTAGES

CHARACTERISTICS	PURPOSE
50 millivolts per degree of roll and pitch at +10 degrees to reference phase.	Antenna stabilization

" * " See system interconnecting wiring diagram, figure 3-4.
" ** " Demand is approximate for system using two indicators. If only one indicator used, reduce indicated total demand by 65 va.

SECTION II
THEORY OF OPERATION

2-1. GENERAL.

The RDR-1 (X-Band) Airborne Radar System fundamentally consists of a pulse-modulated transmitter, a pulse receiver, an indicator, an antenna, a synchronizer-power supply, a stabilization system, and a control panel.

This section covers the general operating theory of the system and includes a block diagram of the system (figure 2-10), a simplified schematic of the control system (figure 2-7), a chart (figure 2-8) showing the sequential operation of the control system, and a chart (figure 2-9) showing the functional operation of the control system. An interconnecting wiring diagram of the system (figure 3-4) is included in section III, and an additional, reproducible, copy is included in section IX. Complete schematic diagrams of the following major components are included in section IX: transmitter-modulator section of the RDR-1B-1 Transmitter-Receiver; receiver section of the RDR-1B-1 Transmitter-Receiver; AFC section of the RDR-1B-1 Transmitter-Receiver; SYN-1B Synchronizer-Amplifier-Power Supply; PPI-1B, D Indicator; ANT-1B, 1E Antenna; CON-1D Control. Detailed circuit theory for each major component is presented in the instruction books as listed in table 2-1.

All references in this handbook, to circuit elements of major components of the system, will be made by symbol numbers. A symbol number will identify the circuit element and the major component in which it is used. Table 2-1 lists the symbol number series and the instruction book (I. B.) number for each major component.

The use of table 2-1 facilitates the identification of the major component in which the referenced circuit element is used. As an example: Tube V3003 is shown to be a circuit element of the modulator-transmitter section of the RDR-1B-1 Transmitter-Receiver which is completely covered in instruction book I. B. -737.

TABLE 2-1. MAJOR COMPONENT SYMBOL NUMBER SERIES AND INSTRUCTION BOOK NUMBERS

SYMBOL NUMBER SERIES	CIRCUIT ELEMENTS USED IN	MAJOR COMPONENT INSTRUCTION BOOK NUMBER
1000-1999	PPI-1B, D Indicator	I. B. -740
2000-2999	ANT-1B, 1E Antenna	I. B. -735
3000-3099	Modulator-transmitter section of the RDR-1B-1 Transmitter-Receiver	I. B. -737
3100-3199	Receiver section of the RDR-1B-1 Transmitter-Receiver	I. B. -737
3200-3299	AFC section of the RDR-1B-1 Transmitter-Receiver	I. B. -737
4000-4999	SYN-1B Synchronizer-Amplifier-Power Supply	I. B. -739
5000-5999	CON-1D Control	I. B. -734
6000-6999	System interconnecting components	I. B. -732

2-2. SYSTEM THEORY.

a. GENERAL. --The transmitter and receiver operate with the same antenna. Electronic switching simultaneously connects the antenna to the transmitter and disconnects the receiver during pulse transmission. Following the completion of pulse transmission, the antenna is switched from the transmitter to the receiver. The switching cycle is performed for each transmitted pulse.

Since the velocity of radiated wave propagation is constant with respect to time, the time interval between the transmission of a pulse and the display of its received echo along a time base line is represented as distance on the indicator. Distance indications are calibrated in terms of nautical miles.

For the display of areas on the indicator screen, the radiated beam is traversed in the horizontal plane by rotating the antenna. To provide correct azimuth presentation of the beam coverage, the indicator sweep trace is rotated about its origin in synchronism with the rotation of the beam. The indicator

sweep trace starts at the apex of the overlay on the indicator and is caused to traverse the face of the indicator tube, linearly with respect to time, while the trace is simultaneously rotated across the indicator tube to form a sector scan display. The resulting display indicates the range, and the azimuth bearing of targets with respect to the heading of the aircraft. The starting point of the sweep trace, the apex of the overlay (6, figure 4-5), represents the position of the aircraft. Therefore, targets appearing on a line extending vertically from the apex of the overlay, zero degrees in azimuth (3, figure 4-5), are indicated to be in line with the heading of the aircraft. Since zero degrees in azimuth represents the heading of the aircraft, targets appearing to the right or left of the zero-degree line are to the right or left of the aircraft's heading and their actual bearings are determined, by interpolation, by their proximity to the azimuth calibrations on the face of the indicator.

The radiation angle of the radar beam is determined by the tilt angle of the antenna. The normal, or zero tilt angle provides beam radiation in the horizontal plane. Facilities are provided for adjusting the tilt angle of the antenna, to provide beam coverage to any selected angle from 15 degrees below to 15 degrees above the horizontal, independently of its azimuth scan function. The antenna-tilt angle may be adjusted, remotely, by the ANT-TILT control on the CON-1( ) Control.

The scanned area, as displayed on the indicator screen, is caused to hold its relative position on the screen, during such pitching and rolling of the aircraft as is encountered in normal flight, by the combined actions of the aircraft's vertical gyro and the stabilization system of the RDR-1 Airborne Radar System, providing line-of-sight stabilization within plus or minus 20 degrees at zero tilt angle of the antenna. To accomplish this, the normal (zero-degree) antenna tilt angle is referenced to the vertical gyro in the aircraft; then, any pitching or rolling of the aircraft (within stabilization limits) is translated into pitch and roll error voltages, by the vertical gyro, and these voltages initiate corrective action through the stabilization system to maintain a constant radiation angle.

It is a mechanical function of the antenna to traverse the radiated beam in azimuth. To accomplish this, the reflector and radiating element assembly is rotated 360 degrees about its azimuth axis, by an azimuth drive motor, at the rate of 15 rpm plus or minus 3 rpm.

The azimuth scan angle, as displayed on the indicator screen, is limited to a sector of 240 degrees by the calibrated overlay covering the face of the indicator tube (figure 4-5); that is, 120 degrees to either side of the aircraft's heading. This scan angle may be further limited by the configuration of the aircraft and by the physical positioning of the antenna assembly in the individual installation. The actual usable azimuth scan angle, therefore, is determined by the extent of the unobstructed, line-of-sight beam path available, forward and to each side of the focal point of the antenna, up to a maximum of 240 degrees. (See figure 4-1.)

b. DEVELOPMENT AND RADIATION OF TRANSMITTING ENERGY.

(1) DEVELOPMENT OF PULSES.--The sequence and timing of the equipment in operation is dependent on simultaneous triggers furnished to the transmitter and indicator(s). These triggers are generated by the synchronizer, in the SYN-1B Synchronizer-Amplifier-Power Supply, which is in turn controlled in frequency by the 115-volt, 380- to 420-cps primary power supply. This 115-volt 380- to 420-cps voltage triggers the blocking-oscillator tube in the synchronizer and therefore holds the frequency of the generated triggers to 400 cps, plus or minus 20 cps.

When the modulator in the transmitter is triggered, it causes the magnetron oscillator to be energized (pulsed) for a very short period of time (approximately 1.5 microseconds for all search operations and 2.5 microseconds during beacon operation). This process is repeated between 380 and 420 times per second. The operating sequence starts with a trigger to the switch driver tube V3003 which conducts and, in turn, triggers the thyratron switch tube V3002 which discharges the pulse-forming network Z3003 through the pulse transformer

T3005 and allows the magnetron oscillator V3004 to function. The discharge of the pulse-forming network Z3003 provides a high-amplitude, high-powered pulse which fires the magnetron, thus producing the high-powered pulse of microwave energy. The magnetron-oscillator tube V3004 is a fixed-frequency, type 2J55, magnetron operating in the range from 9345 to 9405 megacycles per second.

By using a modulating pulse of short duration, the transmitted power output from the magnetron greatly exceeds its normal average power rating. A pulse power of 40-kw peak is thus generated and it is this feature which accounts for the production of range and echo intensity necessary for radar detection.

When the magnetron fires, the high-powered pulse of microwave energy is directed to the antenna through the waveguide. To prevent any of the transmitting energy from reaching the receiver circuits, the TR tube V3007 fires during pulse transmission and effectively isolates the receiver section of the mixer which contains the two signal crystals, CR3004 and CR3005.

(2) RADIATION, SEARCH AND BEACON OPERATIONS.--The transmitting energy from the magnetron oscillator, as directed through the waveguide, feeds the radiating element of the antenna. This radiating element, employing a circular ring feed, directs the energy into the parabolic reflector E2001 which reflects and focuses the energy into a narrow, horizontally polarized, pencil beam.

The width of the pencil beam is dependent on the operating frequency of the equipment and the size (diameter) of the reflector. When a 22-inch (diameter) reflector is used at the operating frequency of this equipment (9375 plus or minus 30 megacycles per second), the radiated pencil beam will have a width of approximately 3.8 degrees at half-power points.

(3) RADIATION, GROUND MAPPING OPERATIONS.--For ground mapping operations, a vertically polarized beam, having cosecant-squared

characteristics in the vertical plane, is radiated by the antenna. Such a beam provides relatively equal energy distribution over the ground area illuminated. Echoes from similar targets at various ranges within the area scanned are therefore returned with relatively equal intensity.

From an altitude of 20,000 feet the cosecant-squared beam would illuminate ground ranging from approximately five to fifty miles at optimum antenna tilt.

To change the radiated beam from a horizontally polarized pencil beam to a vertically polarized cosecant-squared beam, the antenna's parabolic reflector is equipped with a spoiler grid on its inner surface, and a "ferrite" beam rotator (Gyrator) surrounded by an energizing coil, included as part of the antenna feed.

The spoiler grid is invisible to the horizontally polarized wave used for all search operations, therefore, such a wave is formed into a symmetrical pencil beam by the parabolic reflector.

For ground mapping operations (CONTOUR-MAP switch S5002 in MAP position), the energizing coil produces a d-c magnetic field around the ferrite causing the ferrite to become anisotropic, i.e., its microwave properties are not the same in all directions. In its quiescent state (no magnetic field present) microwave incident to the ferrite pass without noticeable attenuation or alteration. However, when the d-c magnetic field is present, the anisotropic properties of the ferrite cause a wave, incident to it, to be rotated (in this case, 90 degrees), changing the polarization of the radiated wave from horizontal to vertical.

Vertically polarized waves see the spoiler grid as a relatively solid reflecting surface and are reflected from it, as well as from the parabolic reflector, fanning the radiated beam in the vertical plane to provide a beam having the desired cosecant-squared characteristics.

Vertically polarized echo signals result from a vertically polarized radiated beam. The echo signal incident to the ferrite is therefore vertically polarized. It is again rotated 90 degrees by the ferrite, changing the polarization back to horizontal. The signal then follows the normal path back to the receiving circuits.

c. RECEPTION OF REFLECTED SIGNALS. --When transmitted pulses of microwave energy encounter an object having reflective or reradiating characteristics, a portion of the transmitted energy is reflected along the same general path to the antenna. This energy (echo) is intercepted by the parabolic reflector, focused on the radiating element of the antenna, which is now acting as a receiving element, and directed through the waveguide to the mixer section of the duplexer-mixer.

The electronic switching as performed by the TR tube V3007, in the duplexer-mixer, allows signal reception during the interval between transmitted pulses.

To ensure minimum absorption of received power by the transmitter, a pair of wide-band, contact, anti-TR tubes, V3005 and V3006, are included in the duplexer-mixer assembly. These ATR tubes are placed along the waveguide section between the TR tube V3007 and the magnetron oscillator V3004. During transmission, these ATR tubes fire to present a path of low impedance through the waveguide in the direction of the antenna. During the period of reception, between transmitted pulses, these ATR tubes are quiescent and present a high impedance, at their point of contact, in the direction of the magnetron oscillator and thus prevent the dissipation of received energy in the transmitter.

The radar receiving system is essentially that of a superheterodyne circuit having bandpass characteristics for video signals. The i-f bandwidth of the receiver is one megacycle at the three-db points with a 30-megacycle center frequency. This is the intermediate frequency at which amplification and detection of the received signals takes place.

The received echo signal is directed into the mixer section of the duplexer-mixer W3002 where it is heterodyned with the r-f output from the local oscillator. The result is a beat frequency of 30 megacycles which is taken from the signal crystals CR3004 and CR3005, in the mixer section of the duplexer-mixer and fed to the receiver input terminals J3102 and J3101.

Because receiver sensitivity and bandpass characteristics are critical with respect to the center frequency, accurate frequency control of the local oscillator is essential. Since the local-oscillator frequency is maintained at 30 megacycles per second below the transmitted frequency, by the action of the afc circuit, the resulting beat frequency is the required 30 megacycles per second. The afc circuit, operating on the d-f (difference-frequency) principle, employs a small portion of the magnetron-oscillator output which is directed to the afc mixer section of the duplexer-mixer W3002. When the magnetron fires, this energy sample is combined with the output of the local oscillator and produces a beat frequency equal to the difference between the magnetron-oscillator frequency and the local-oscillator frequency. This beat-frequency signal is taken from the afc crystal CR3006 and fed to the input of the afc circuit. Variations in the beat frequency, above or below 30 megacycles per second result in amplitude variations in the local-oscillator control voltage developed by the afc circuit. This control voltage is fed to the reflector anode of the klystron local-oscillator tube V3008 to complete the afc feedback loop. A change in the amplitude of the local-oscillator control voltage causes a corresponding change in the local-oscillator frequency in the direction necessary to compensate for the beat-frequency deviation. This continuous afc action assures a local-oscillator output frequency which is, at all times, 30 megacycles per second below the transmitted frequency.

The 30-megacycle signal, developed as the result of mixing the received echo signal with the r-f output of the local oscillator, is fed through a cascode i-f amplifier, in the receiver, to six stages of i-f amplification, demodulated, amplified in the video amplifier section of the receiver and fed equally to two cathode-follower output channels.

d. RECEPTION OF BEACON RESPONSE SIGNALS. --When the BEACON facility incorporated in the RDR-1B-1 Transmitter-Receiver is in use, the principles of ECHO reception do not apply.

During BEACON operation the RDR-1B-1 Transmitter-Receiver produces 2.5-microsecond pulses suitable for interrogating (triggering) "X"-band ground-sited beacons within the ground area illuminated by the radiated beam. The cooperative ground-sited beacons, when interrogated, radiate response signals in the form of conventional coded spaced groups. The independent communication link thus established is called the "response link". Response signals from ground-sited beacons, not echo signals from the radiated beam, are then received by the airborne equipment.

Because beacon response signals are on a frequency different from the interrogation frequency, no interference from echo signals is present in the display. Since one-way transmission is involved in the radar-interrogation and beacon-response links, attenuation by weather is of little significance.

A second local oscillator (beacon local oscillator) in the RDR-1B-1 Transmitter-Receiver, maintained at a frequency 30 mc below the BEACON-response frequency, is employed to provide the 30-mc if. required by the receiver.

To hold the beacon local oscillator at a given frequency some r-f reference standard is required since the magnetron involved is in the ground-sited beacon, distant from the airborne radar. The reference standard is a resonant cavity designed to resonate at 9280 mc which is 30 mc below the response frequency (9310 mc) of "X"-band beacons. Since ground-sited "X"-band beacons transmit at a fixed frequency, the afc system of the receiving equipment operates on the "absolute frequency" principle. In this system a modulated-sawtooth sweep voltage is applied to the reflector anode of the beacon local oscillator which causes the local-oscillator frequency to sweep across the point of cavity resonance.

When the local-oscillator frequency equals the cavity-resonant frequency, the afc circuit stops the sweep of the control voltage and locks the local oscillator at that frequency.

e. INDICATION OF RECEIVED SIGNALS.

(1) GENERAL.--It is the function of the indicator to provide a visual presentation of the received signals. The information contained in the received signals must be displayed to indicate the distance which the signals traveled, the intensity with which they arrive, and the relative bearing from which they approach.

The RDR-1 Airborne Radar System is designed to accommodate one or two indicators. Each indicator utilizes a separate azimuth servo system and a separate servo amplifier. Both azimuth servo systems receive simultaneous azimuthbearing data from a common source in the antenna. Therefore, the rotation of the sweep trace of each indicator is synchronized with antenna rotation and with each other.

Each indicator is equipped with a sweep generator and a range mark generator. Both indicators receive simultaneous triggers originating in the synchronizer section of the SYN-1B unit. Therefore, the start of the sweep trace in each indicator occurs simultaneously regardless of the range selected on the individual indicator.

Identical, instantaneous, target information (video) is fed to both indicators from separate cathode-follower circuits in the video amplifier section of the receiver.

Each indicator has independent range selection, display brilliance, and overlay illumination controls. Since these controls effect only the indicator to which they belong, it is possible for each operator to select or change ranges at any time, adjust display brilliance according to ambient lighting conditions, and to illuminate the calibrated overlay as desired, without effecting the other indicator.

(2) DEFLECTION. --To produce the range and azimuth indications on the indicator screen, a deflection yoke is used. Decentering is achieved by a geared, permanent magnet assembly, which is responsible for positioning the start of each sweep trace at the apex of the overlay. The deflection yoke, L1001, is set in a revolving mount driven by the yoke drive motor B1001. This yoke fits in front of the decentering magnets and around the neck of the KRT. Sweep voltages are applied to deflection yoke L1001 which cause the electron beam of the KRT to travel from the apex of the overlay to the periphery of the display, thus generating the sweep trace which is caused simultaneously to traverse the indicator screen in a clockwise direction. Since each sweep trace starts at the apex of the overlay, this becomes the point of reference from which is generated the circular pattern.

(3) RANGE OF TARGETS. --Proper synchronization of the sweep gate and sweep-generator circuit, with respect to the transmitted pulse, establishes the zero range point at the sweep origin on the indicator screen. Received signals are detected, amplified and displayed along the sweep trace at a later time than the sweep origin. Consequently, the interval between the main transmitted pulse and the received signal is represented in range along the linear sweep trace. Range calibration along the sweep trace is provided by the range marker circuits which furnish accurate range marks in the form of concentric circles at predetermined radii corresponding to the range function of the equipment. The nominal operating range is proportional to the distance from the apex of the overlay to a point along the edge of the indicator screen vertically opposite the apex. This point represents the heading of the aircraft (zero degrees in azimuth). It is possible to observe maximum range indications at this point. At any other point around the periphery of the display, the maximum possible range observation is somewhat less, being in direct proportion to the linear distance between the apex and the periphery at every point.

(4) AZIMUTH BEARING OF TARGETS. --The rotation of the linear sweep trace is synchronized with the azimuth rotation of the antenna. At every

instant, the position of the sweep trace on the indicator screen indicates the azimuth position of the antenna. Therefore, received signals appearing on the indicator screen will be indicated in azimuth position, with respect to the heading of the aircraft, by their angular displacement either side of zero heading.

(5) CONTOUR PRESENTATION.--When examining a rain or storm area, the intensity of the return signal will vary depending upon the concentration of moisture reflecting the beam. Although the intensity of the return signal may vary, the PPI presentation of moisture-bearing cloud formations may appear almost uniform in intensity. This is due to the inability of the phosphorescent material in the cathode-ray tube to distinguish more than a limited range of light intensities. The ISO-ECHO contour circuit included with the receiver eliminates this condition. This circuit, when energized, alters the normal radar presentation to display high rainfall rates as black holes in the signal return.

The action of the contour circuit is relatively simple and functions to erase radar return signals greater than a preselected level, thus making the detection of the more intense rain areas possible. The areas of greatest turbulence within thunderstorm clouds are associated with the areas of greatest rainfall-rate gradient and it is essential to distinguish these areas from those of relatively little turbulence. The display resulting from contour circuit action on the return signal shows areas of high rainfall rate as black holes surrounded by light areas (relatively light rainfall) making the visual evaluation of varying degrees of light intensity in the display unnecessary.

Illustration L of figure 4-2 is a photograph of a PPI display of a thunderstorm area. The sweep range is 50 miles with range marks spaced at ten-mile intervals. The outer edge of the white area of the rain return signal defines the minimum rainfall rate at which echoes are visible on the radar (near zero rain). The outer edges of the black holes in the rain-return centers outline the areas within which the rainfall rate is greater than this by a predetermined amount. Where the rate of rainfall changes rapidly, maximum turbulence is

normally found. Therefore, where the white line between the no-rain area and the heavy-rain area is thinnest, the greatest turbulence will usually be found.

(6) STC CIRCUIT. --The amplitude of echo signals varies as a second power inverse function of target range for beam-filling targets such as clouds. Without control of receiver gain, the PPI presentation of cloud targets being approached would vary in intensity from very strong signals at short range to considerably weaker signals at long range.

The object of the STC (sensitivity time control) circuit is to ensure that echo signals are presented with approximately equal intensity from similar targets ranging from near zero to approximately 25 nautical miles, and to prevent limiting, in the i-f section of the receiver, by strong signals from close targets.

The depth of STC control is set by the adjustment of variable resistor R3188. This adjustment is set to provide, at three miles, a gain reduction of 18.5 db from the gain at 25 miles. This setting produces a gain reduction, at one mile of approximately 28 db below maximum.

Thus, the receiver gain, being reduced to a relatively negative value at the instant each trigger pulse is applied to the STC tube V3155, is permitted to rise for a time interval, following each transmitted pulse, according to an inverse exponential curve.

The result is that all echo signals from similar targets ranging from near zero to approximately 25 miles are presented with relatively equal intensity.

The STC circuit is disabled during ground-mapping operations since the use of a radiated beam having cosecant-squared characteristics eliminates the need for it.

f. SERVO SYSTEM

(1) GENERAL. --Antenna stabilization and the ability of an airborne radar to selectively scan at various angles above and below the plane-of-flight path are essential functions which are combined in this equipment.

The complete servo system of the RDR-1 Airborne Radar System, as shown in the block diagram (figure 2-1) incorporates an azimuth servo system, a stabilization servo system, and facilities for the remote control of the tilt angle of the radar beam.

The azimuth servo system (figures 2-2 and 2-3) synchronizes the rotation of the indicator sweep trace with the azimuth rotation of the antenna. The system ensures that, at every instant, the position of the sweep trace, as displayed on the calibrated face of the indicator, will indicate the azimuth position of the antenna. The sweep trace is aligned at zero heading on the indicator when the antenna is looking straight ahead; therefore, since the sweep trace is caused to follow the azimuth rotation of the antenna, targets will be displayed in azimuth with respect to the heading of the aircraft.

Operation of the azimuth servo system is covered in more detail in paragraph 2-2f. (2).

The stabilization servo system (figures 2-4 and 2-5) stabilizes the antenna against roll and pitch of the aircraft, thereby holding the PPI display relatively steady during such rolling and pitching as is encountered in normal flight. Antenna line-of-sight stabilization is effective for pitch and roll attitudes of the aircraft up to approximately plus or minus 25 degrees at zero tilt angle of the antenna.

Operation of the stabilization servo system is covered in more detail in paragraph 2-2f. (3).

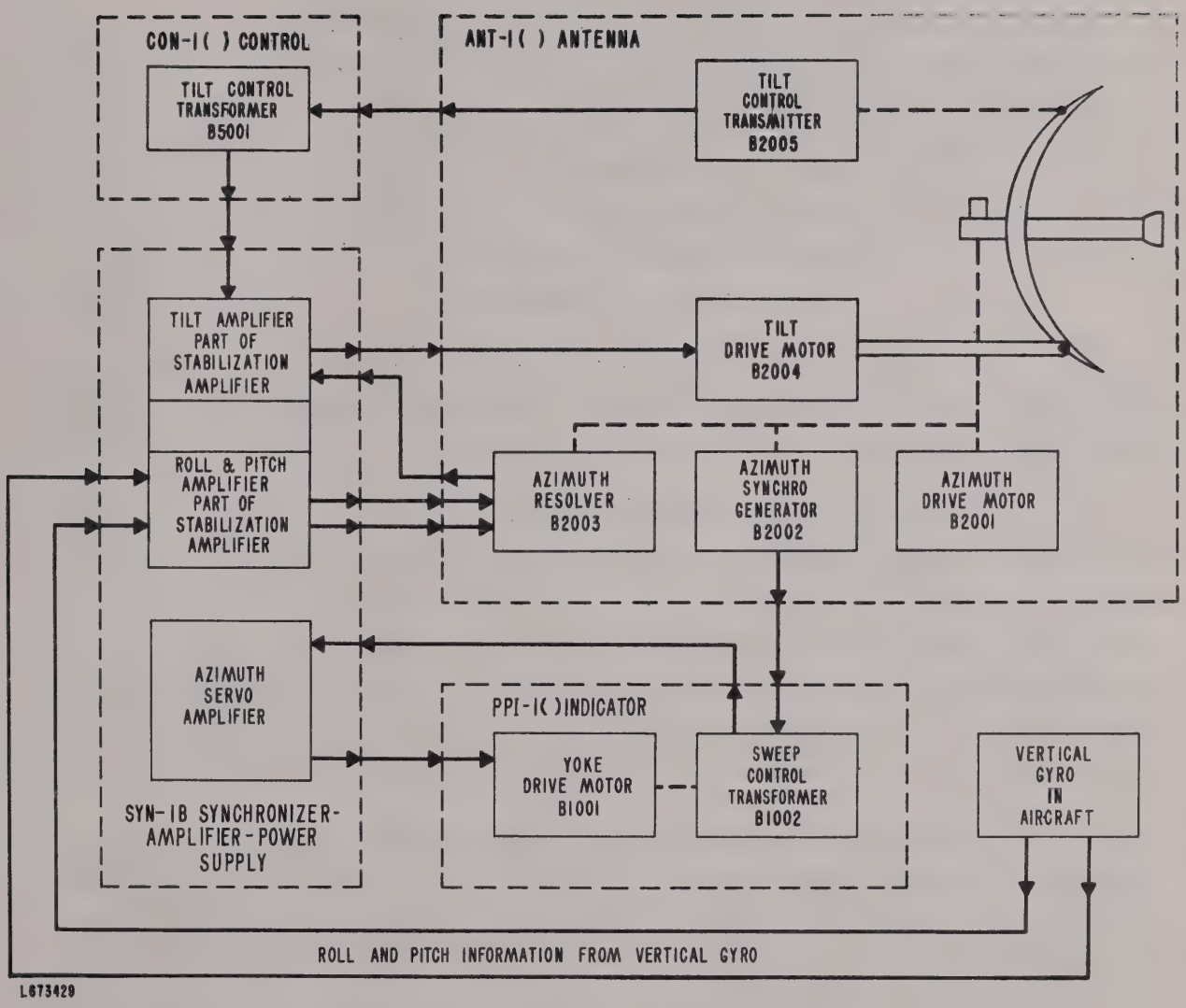


Figure 2-1. Servo System, Part of RDR-1 Airborne Radar System, Block Diagram

Section II
Paragraph 2-2

THEORY OF OPERATION

The complete servo system utilizes five synchro units and three two-phase drive motors. The nomenclature applied to each of these units is based on its application in the system and is as follows:

B1001 Yoke Drive Motor
B1002 Sweep Control Transformer
B2001 Azimuth Drive Motor
B2002 Azimuth Synchro Generator
B2003 Azimuth Resolver
B2004 Tilt Drive Motor
B2005 Tilt Control Transformer
B5001 Tilt Control Transformer

Yoke drive motor B1001, in the PPI-1( ) Indicator, is a servo motor which rotates deflection yoke L1001, and thereby the indicator sweep trace, in synchronism with the azimuth rotation of the antenna.

Sweep control transformer B1002, in the PPI-1( ) Indicator, is a three-phase synchro which acts as a data receiver, sensing device, and error voltage generator. Its rotor is geared to, and follows the rotation of, deflection yoke L1001. Sweep control transformer B1002, by following the rotation of deflection yoke L1001, develops an output (error) voltage which controls yoke drive motor B1001 to synchrnoize the rotation of the indicator sweep trace with the rotation of the antenna.

Azimuth drive motor B2001, in the ANT-1( ) Antenna, operates on 115 volts, 380-420 cps and drives the antenna in azimuth rotation, through reduction gears, at the rate of 15 plus or minus 3 rpm, the speed being governed by the frequency of the input power.

Azimuth synchro generator B2002, in the ANT-1( ) Antenna, is a three-phase synchro which acts as a synchro data generator. Its rotor is geared to the azimuth drive of the antenna and follows antenna rotation. Voltages induced

in its stator windings represent synchro data containing antenna azimuth bearing information. This synchro data is transmitted to sweep control transformer B1002 in the PPI-1 ( ) Indicator.

Azimuth resolver B2003, in the ANT-1( ) Antenna, is a two-phase resolver with its stator windings fixed in position and its rotor shaft geared to the azimuth drive of the antenna. Its stator windings receive electrical roll and pitch data from the aircraft's vertical gyro and its rotor follows the azimuth rotation of the antenna. A voltage is induced in its rotor winding which is the vectorial sum of the roll and pitch error voltages as determined by the instantaneous azimuth position of the antenna.

Tilt drive motor B2004, in the ANT-1( ) Antenna, is a servo motor geared to the tilt axis of the antenna through reduction gears. Its function is to drive the antenna to any desired tilt angle, within the tilt limits of the equipment. Motor speed and direction of drive are controlled by voltages of proper phase and amplitude, supplied to its control phase winding by the tilt servo amplifier section of the SYN-1B Synchronizer-Amplifier-Power Supply.

Tilt control transmitter B2005, in the ANT-1( ) Antenna, is a three-phase synchro which acts as a synchro data generator and transmitter. Its rotor is geared to the tilt axis of the antenna and the synchro data transmitted by its three stator windings contain tilt angle information.

Tilt control transformer B5001, in the CON-1( ) Control, is a three-phase synchro which acts as a data receiver, comparator, and error voltage generator. Its rotor is manually set to any desired tilt angle of the antenna and it compares the angle manually set with the actual tilt angle of the antenna. Any angular difference between the actual antenna tilt angle and the angle manually set, in tilt control transformer B5001, results in the development of an error voltage in its rotor. Any error voltage thus developed is used to control tilt drive motor B2004 which drives the antenna to the correct tilt angle.

(2) AZIMUTH SERVO SYSTEM.--Parts of the azimuth servo system are contained in three major units of the radar system and are integrated through the interconnecting wiring of the system. The azimuth servo system is a closed-circuit, electromechanical control system. (See figures 2-2 and 2-3.)

In operation the primary of step-down transformer T4005 in the SYN-1B Synchronizer-Amplifier-Power Supply is energized by the application of 115 volts, 400 cps taken from the reference phase of the autopilot primary voltage supply source. Transformer T4005 has two secondary windings. Secondary No. 1 (taps 3 - 4) provides 18 volts, 400 cps to the reference phase winding of yoke drive motor B1001 in the PPI-1(D) Indicator(s). Secondary No. 2 (taps 5 - 6) provides 26 volts, 400 cps to the rotor of azimuth synchro generator B2002 in the antenna.

Azimuth drive motor B2001, drives the antenna in azimuth rotation. The rotor of azimuth synchro generator B2002 is directly geared to the azimuth drive of the antenna; thus the synchro receives a constantly changing shaft position. The synchro stator has three windings, 120 degrees apart and Y-connected, and the rotor has one winding. The synchro behaves like a variable transformer in which the rotor is the primary and the stator windings are secondaries. The voltage induced in each of the three stator windings changes as the position of the rotor is altered; thus azimuth synchro generator B2002 produces three constantly changing output voltages which are in effect synchro data for transmission to a remote point. The three stator outputs are connected directly to the three stator windings of sweep control transformer B1002 in each PPI-1( ) Indicator used; therefore, sweep control transformer B1002 receives electrical synchro data. Since its rotor is geared directly to the indicator's deflection yoke L1001, it has its shaft (or rotor) set mechanically as deflection yoke L1001 is rotated. Sweep control transformer B1002 develops an output voltage across its rotor winding and the amplitude and phase of the voltage is determined by the angular difference between the actual rotor position and the position called for by

the synchro data fed to its stator windings. It thus combines the functions of data receiver, follow-up, and sensing element.

When the rotor of sweep control transformer B1002 is set at the position called for by the synchro data, maximum voltage is induced in its rotor; however, in this application the rotor is set at a 90-degree angular displacement from the maximum voltage position, as shown in figure 2-2. In this position no voltage is induced in the rotor. For any angular displacement from its zero-voltage position an error voltage is induced in the rotor and is proportional to the sine of the angle of such displacement. For any position of the azimuth synchro generator rotor, there are two positions of the sweep control transformer rotor for which no voltage is induced. The correct zero (no-voltage) position is the one for which a slight positive (counterclockwise) rotation of the sweep control transformer rotor results in an error voltage having the same phase as the excitation voltage of the azimuth synchro generator rotor. It follows then, that a slight negative (clockwise) rotation of the rotor, from its zero (no-voltage) position, results in an error voltage of opposite phase.

The output of sweep control transformer B1002 is fed to an azimuth servo amplifier in the SYN-1B Synchronizer-Amplifier-Power Supply where it is amplified, and correction made for any phase shift in the process, and then fed to the control phase winding of yoke drive motor B1001, in the PPI-1( )Indicator, the other winding, designated as the reference phase is connected to the same reference voltage source that feeds the rotor of azimuth synchro generator B2002 in the antenna.

The synchro system is so designed that the phase of the error voltage output of sweep control transformer B1002 will drive yoke drive motor B1001 in a direction calculated to reduce the error voltage toward zero. Since this error voltage-reducing process is continuous, when the system is in operation, and since the process is practically instantaneous, the sweep trace on the face of the indicator will, at every instant, indicate the azimuth position of the antenna.

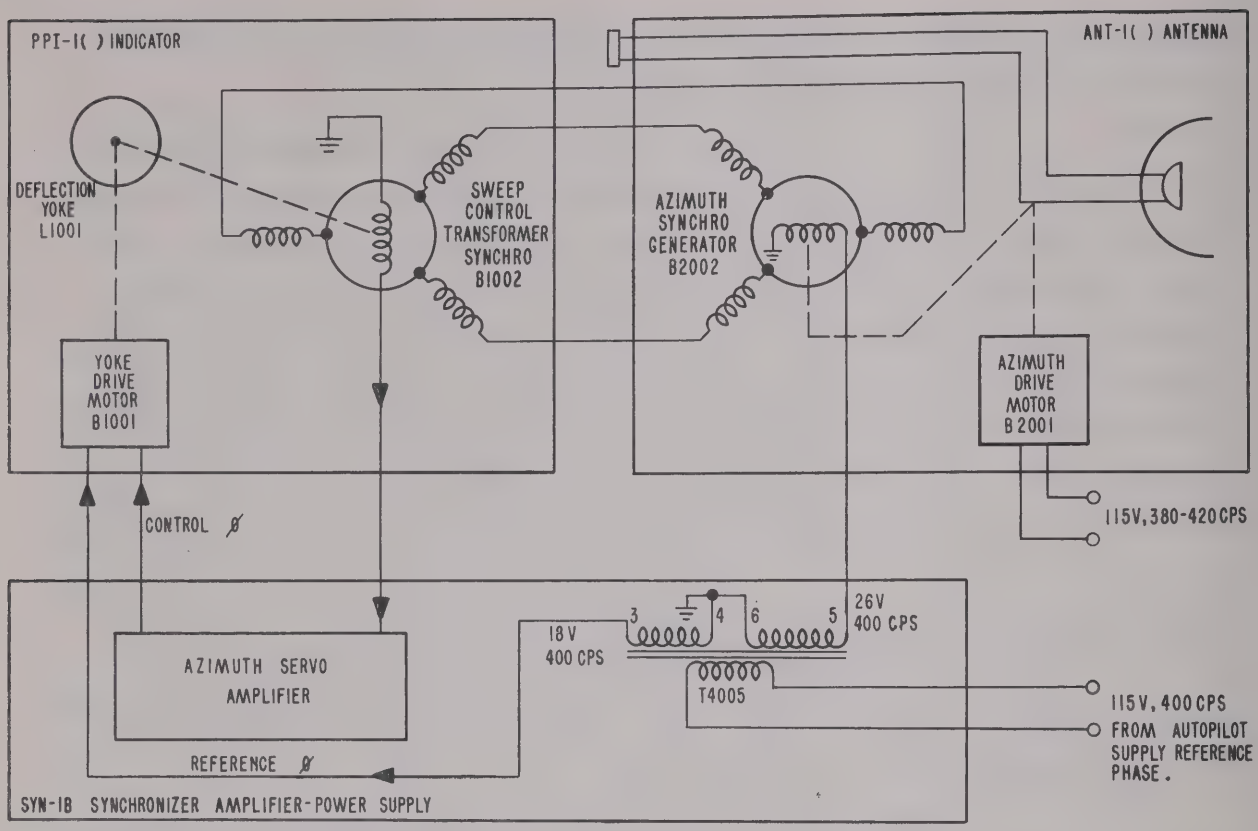


Figure 2-2. Azimuth Servo System, Part of RDR-1 Airborne Radar Servo System, Simplified Schematic Diagram

(3) STABILIZATION SERVO SYSTEM. --The stabilization servo system incorporates remote control of antenna tilt with antenna line-of-sight stabilization.

Parts of the stabilization servo system are contained in three major units of the radar system. (See figures 2-4 and 2-5.) It is a closed circuit, electromechanical control system which requires roll and pitch information, from the aircraft's vertical gyro unit, to achieve antenna stabilization.

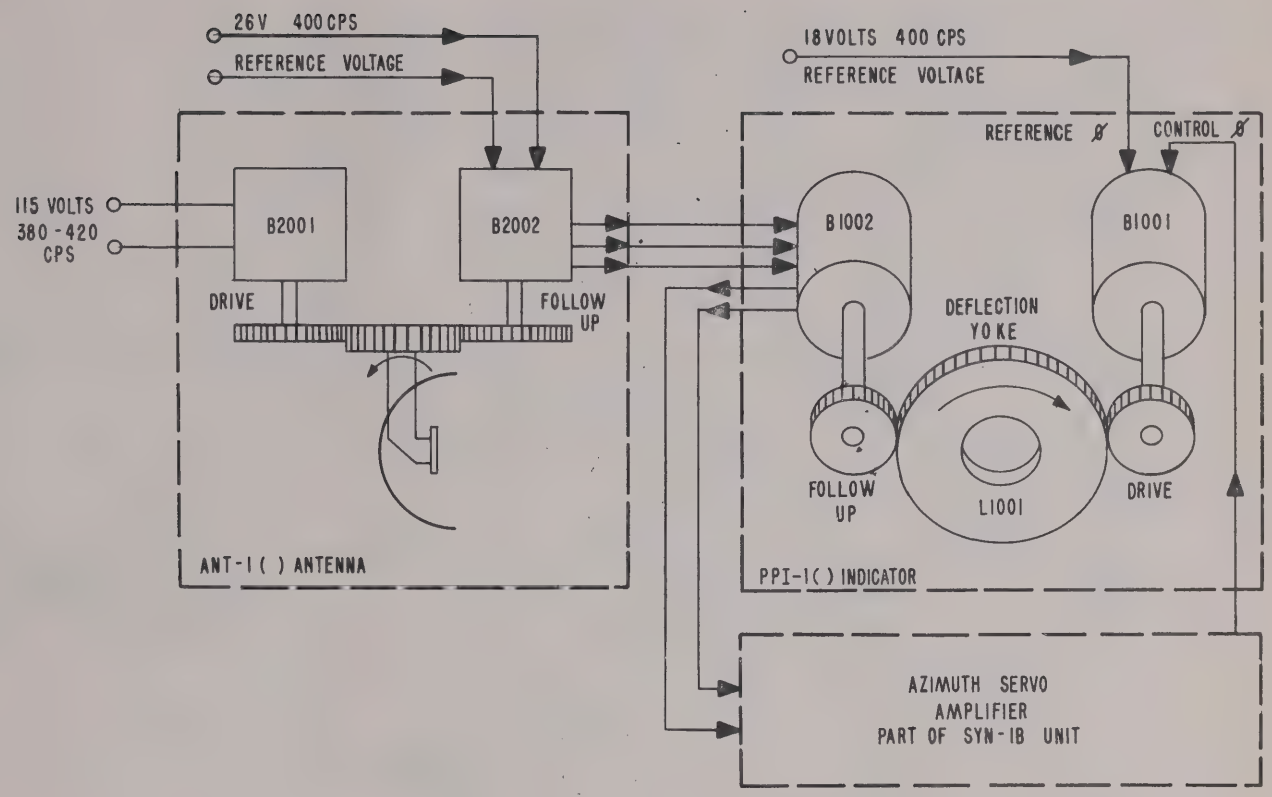


Figure 2-3. Azimuth Servo System, Part of RDR-1 Airborne Radar Servo System, Electromechanical Diagram

Data from the aircraft's vertical gyro unit is fed to the stabilization servo system which automatically corrects the angle of antenna tilt to counteract the pitching and rolling of the aircraft. This prevents the scan from being disturbed by limited maneuvers of the aircraft and ensures impairment of the scope presentation by such maneuvers. The angular limits within which line-of-sight stabilization will function are set by mechanical stops, on the antenna, at approximately plus and minus 25 degrees from zero tilt angle. The center of antenna tilt limits (zero-degree tilt) provides beam coverage in the horizontal plane. For any

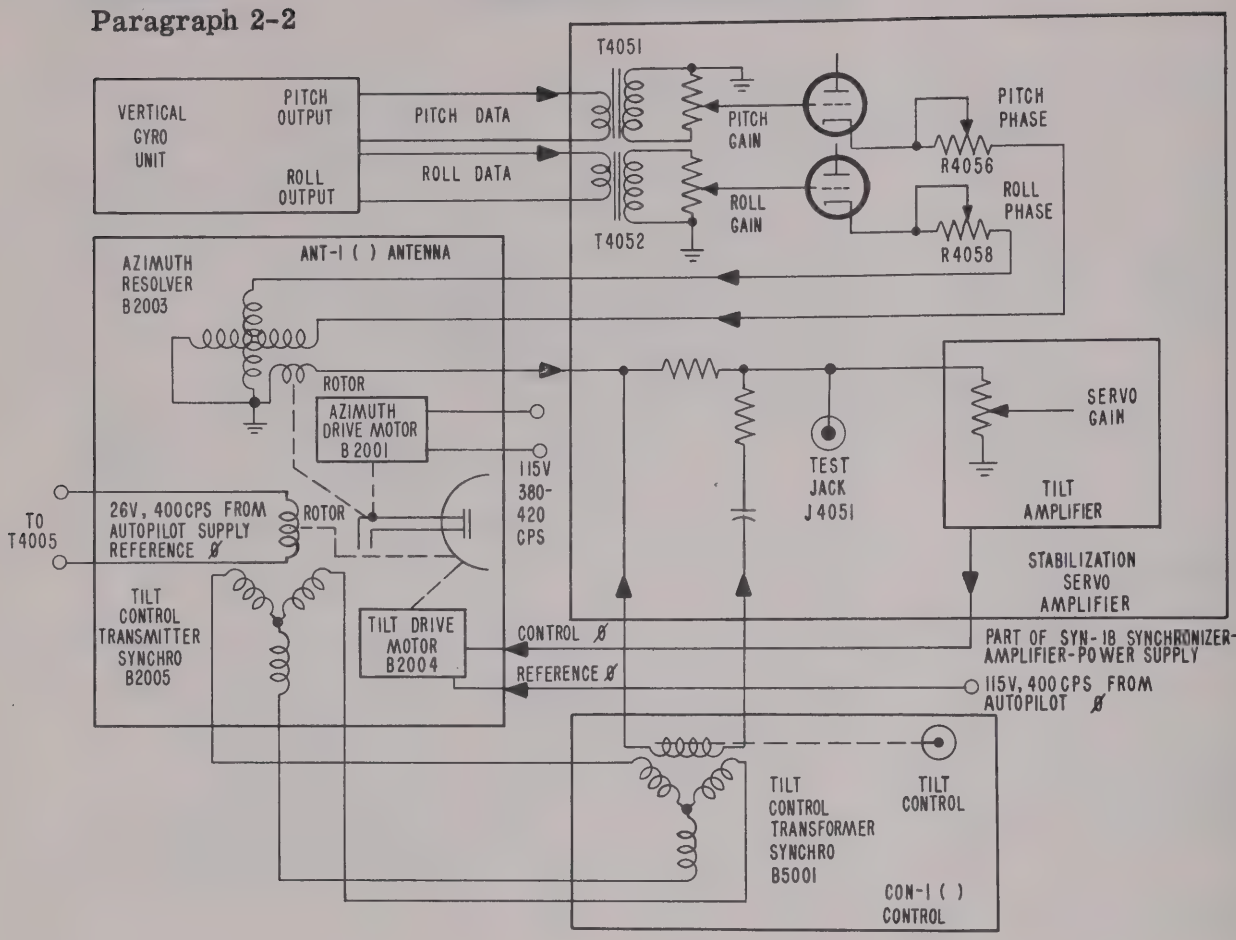


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Figure 2-4. Stabilization Servo System, Part of RDR-1 Airborne Radar Servo System, Simplified Schematic Diagram

preset tilt angle, other than zero tilt, the amount of tilt manually introduced subtracts from the degree of antenna travel possible in the direction of preset tilt and adds an equal amount to the travel possible in the opposite direction. As an example: if the tilt angle of the antenna is manually preset to a ten-degree angle DOWN from the horizontal, to provide a certain amount of ground coverage, in

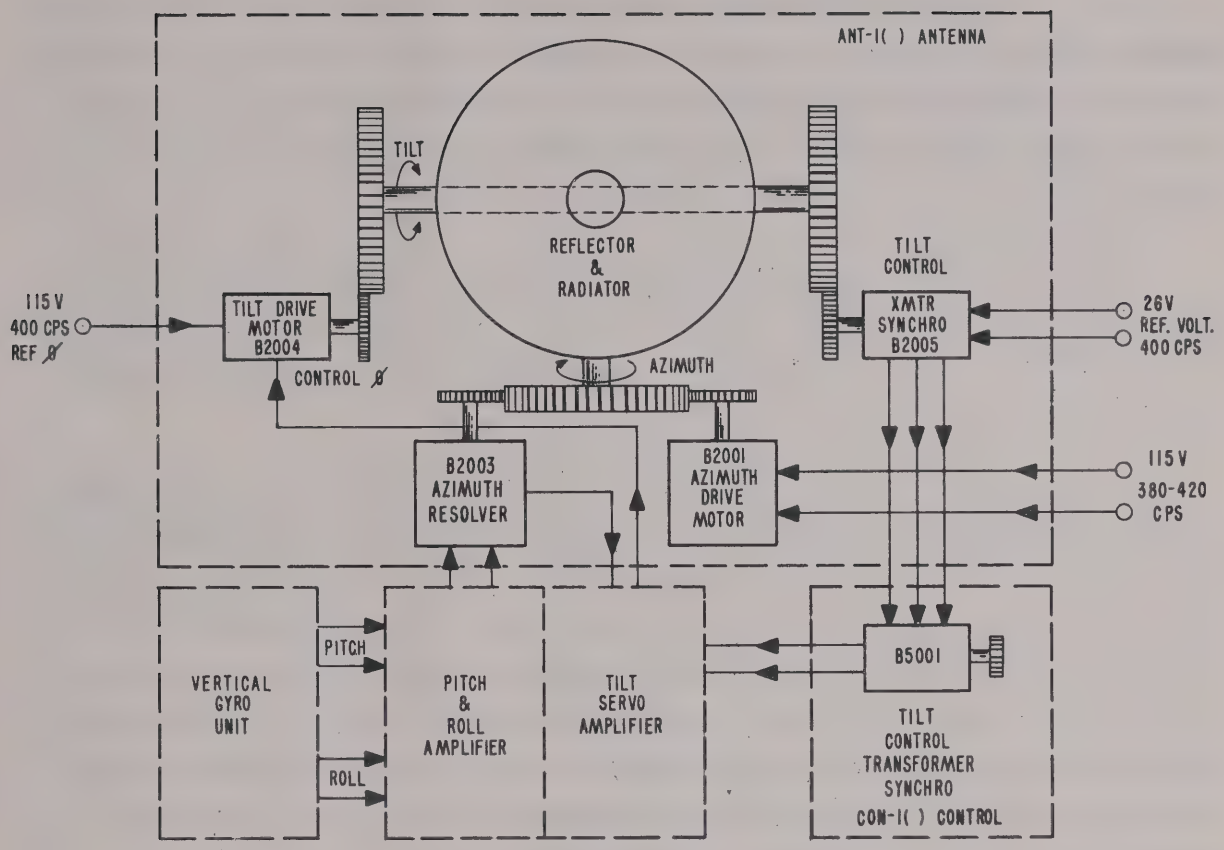


Figure 2-5. Stabilization Servo System, Part of RDR-1 Airborne Radar Servo System, Electromechanical Diagram

level flight the beam will be radiated downward at an angle of ten degrees from the horizontal, and the stabilization system will maintain this angle of radiation with respect to the horizontal for any pitch angle of the aircraft within the limits of: nose UP 15 degrees and nose DOWN 35 degrees. In addition, the stabilization system will compensate for roll attitudes of the aircraft within the stabilization limits.

Voltages representing the roll and pitch angles of the aircraft are obtained from the aircraft's vertical gyro unit and are fed, through amplifiers, to the stator windings of a two-phase resolver mounted in the antenna. The relative azimuth angle of the antenna is introduced as the mechanical rotation of the resolver rotor.

In operation, the antenna is rotated in azimuth by azimuth drive motor B2001 which operates on 115 volts, 380-420 cps. The rotor of azimuth resolver B2003 is geared to the azimuth drive of the antenna, at a gear ratio of 1:1, and follows antenna rotation.

Azimuth resolver B2003 is a two-phase synchro having two stator windings spaced 90 degrees apart, and two rotor windings spaced 90 degrees apart. Only one rotor winding is used in this application. The resolver acts like a variable transformer having two primaries (stators) placed at right angles to each other, and one rotatable secondary (rotor) capable of maximum coupling with one or the other primaries for each 90 degrees of rotation. The PITCH output of the aircraft's vertical gyro, after amplification, is fed to one stator winding of the resolver, and the ROLL output, after amplification, is fed to the other stator winding.

The output voltage from the resolver rotor winding represents the approximate antenna tilt angle correction necessary at any instant to compensate for roll and pitch of the aircraft. This voltage is added to the rotor output voltage from the manually operated tilt control transformer B5001, and the resulting voltage is the vectorial sum of the two voltages. This voltage is amplified in the stabilization servo amplifier section of the SYN-1B Synchronizer-Amplifer-Power Supply and is used to control the tilt angle of the antenna through tilt drive motor B2004.

Tilt transmitter synchro B2005, in the antenna, is a three-phase synchro transmitter. The rotor of synchro B2005 is geared, at a gear ratio of

21:12 (1.75:1) to the tilt axis of the antenna. The rotor acts like the primary winding of a transformer and is energized with a reference voltage of 26 volts, 400 cps from transformer T4005 in the SYN-1B Synchronizer-Amplifier-Power Supply. The primary of transformer T4005 is connected to the autopilot phase of the 115-volt, 400-cps primary power supply which acts as the reference phase for the entire servo system. A voltage is induced in each of the three stator (secondary) windings and these three induced voltages vary as the tilt angle of the antenna changes. These three voltages represent synchro data to be transmitted to a remote point.

The three stator winding outputs (synchro data) of tilt transmitter synchro B2005 are fed to the three stator windings of tilt control transformer synchro B5001, in the CON-1( ) Control unit, wherein the field of the transmitter rotor is reproduced.

With no roll or pitch input to azimuth resolver B2003, the antenna at zero-degree tilt, and the tilt control transformer B5001, in the CON-1( ) Control, manually set to indicate zero-degree tilt, no error voltage should be induced in the rotor of tilt control transformer B5001. To satisfy this requirement, the rotor of B5001 is set at a 90-degree angular displacement from the position called for by the synchro data and this will be the zero (no-voltage) position for the rotor of tilt control transformer B5001. For any position of the tilt transmitter synchro B2005 rotor, there are two positions of the tilt control transformer B5001 rotor (180 degrees apart) for which no error voltage will be induced. The true zero position is the one for which a slight positive (counterclockwise) rotation of the tilt control transformer rotor results in an error voltage having the same phase as the excitation voltage of the tilt transmitter synchro rotor B2005.

Assuming a condition of no error voltage output from the rotor of tilt control transformer B5001, which means that the rotor of B5001 is zeroed with respect to the rotor of tilt transmitter synchro B2005, then, any angular movement of either rotor will cause an error voltage to be induced in the rotor

of tilt control transformer B5001. This induced (error) voltage will be proportional to the sine of the angle of any such angular difference existing between the position of the tilt transmitter synchro rotor with respect to its zero position, and the position of the tilt control transformer rotor with respect to its zero position.

Finally, one winding of the two-phase tilt drive motor B2004, in the antenna, is connected to the reference phase of the 115-volt, 400-cps primary power supply. This winding is designated as the reference phase. The second winding, designated as the control phase, is connected to the output of the tilt servo amplifier, in the SYN-1B Synchronizer-Amplifier-Power Supply, which provides the amplified control voltage.

In operation the error voltages are amplified to provide control voltages, of proper phase and amplitude, which are then fed to the control phase of tilt drive motor B2004 driving the motor in the direction required to maintain a constant beam radiation angle, as manually set into tilt control transformer B5001 in the CON-1( ) Control, throughout the entire 360 degrees of rotation, automatically correcting the antenna tilt angle to compensate for any pitching and rolling of the aircraft within stabilization limits.

(4) MECHANICS OF REMOTE CONTROL OF ANTENNA TILT. --Figure 2-6 illustrates the mechanics associated with the remote control of antenna tilt. The additional components of the servo system required for antenna stabilization have been omitted from figure 2-6 to simplify the illustration. All of the components shown, however, are also a part of the stabilization servo system.

The important features illustrated in figure 2-6 are the gear ratios (BC) and (GH), and the mirror effect of the parabolic reflector of the antenna.

It should be noted that when the ANT-TILT control knob (A, figure 2-6) is set to indicate any degree of antenna tilt, within the tilt limits inscribed on the CON-1( ) Control Panel, the radar beam is radiated at the angle

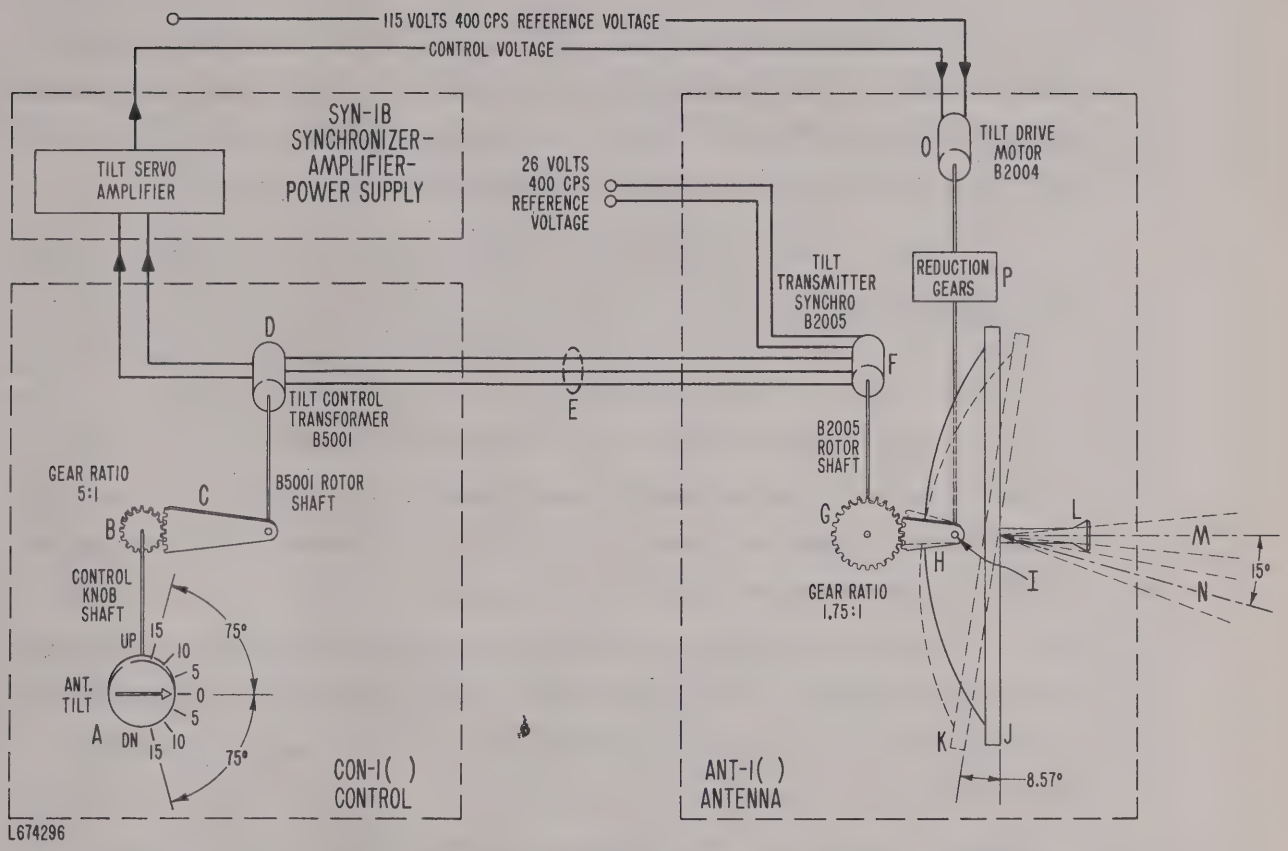


Figure 2-6. Servo Linkage For The Remote Control of Antenna Tilt, Part of RDR-1 Airborne Radar Servo System

indicated, with respect to the horizontal plane. This is true for level flight when no roll or pitch correction voltages are being supplied to the servo system by the aircraft's vertical gyro, and this condition is assumed throughout this paragraph.

To facilitate more accurate manual settings of the desired tilt angle, the tilt angle scale inscribed on the CON-1( ) Control Panel (from 15 degrees UP, through zero, to 15 degrees DOWN), a total of 30 degrees of calibration is expanded to occupy an arc of 150 degrees around the ANT-TILT control knob (A, figure 2-6). Therefore, the ANT-TILT control knob must be rotated on actual 75 degrees to indicate a 15-degree change in the radiation angle of the radar beam.

In level flight, with the arrow on the ANT-TILT control knob (A, figure 2-6) indicating zero degree, and the antenna reflector (J) positioned at zero degree in tilt, tilt control transformer B5001 is electrically zeroed with tilt transmitter synchro B2005. The servo system is static since no error voltage exists, and the radar beam (M) is radiated in the horizontal plane.

Now, when the ANT-TILT control knob (A) is turned clockwise an actual 75 degrees, the arrow on the knob will indicate an antenna tilt angle of 15 degrees DOWN. Because of the 5:1 ratio between the pinion gear (B), on the control knob shaft, and sector gear (C), on the tilt control transformer rotor shaft, the rotor of tilt control transformer B5001 (D) will be rotated an actual 15 degrees and an error voltage will be developed in the rotor. The error voltage thus developed represents an order calling for the antenna to tilt the radar beam 15 degrees DOWN from the horizontal plane.

To accomplish this the error voltage is fed to, and is amplified by, the tilt servo amplifier section of the SYN-1B Synchronizer-Amplifier-Power Supply from where it is fed, as a control voltage, to the control phase of tilt drive motor B2004 (O). The tilt drive motor then drives the antenna reflector, through reduction gears (P), from reflector position (J) to reflector position (K). Note that the radar beam is deflected 15 degrees, from position (M) to position (N), while the antenna reflector is tilted only 8.57 degrees (approximately). The ratio of beam deflection to reflector tilt is 1.75:1. This is accomplished by maintaining the antenna feed (L) in a fixed position while tilting the antenna reflector which causes the radar beam to be deflected 1.75 times the degree of reflector tilt; i.e., 1.75 x 8.57 degrees = 14.9975 degrees.

Since the mirror effect of a fixed feed and tilted reflector causes the degree of radar beam deflection to exceed the degree of reflector tilt, some means of compensation is required to cause the error voltage to diminish to zero when the radar beam reaches the desired degree of tilt. This compensation is supplied by the 21:12 (1.75:1) gear ratio between the sector gear (H), the hub of

which is fixed to the tilt axis (I) of the antenna, and drive gear (G), which is attached to the rotor shaft of the tilt drive transmitter synchro B2005 (F). When the antenna reflector tilts 8.57 degrees, segment gear (H) moves 8.57 degrees with the reflector, and drives the rotor of B2005 15 degrees, through drive gear (G). Because the rotor of tilt transmitter synchro B2005 (F) has now moved 15 degrees in angular rotation, it is again electrically zeroed with the rotor of tilt control transformer B5001 (D), reducing the (error) voltage to zero. The system is once again static but the radar beam is now radiated at a tilt angle 15 degrees DOWN from the horizontal plane.

g. CONTROL SYSTEM.

(1) GENERAL. --The control system included in the RDR-1 (X-Band) Airborne Radar System is shown in the simplified schematic, figure 2-7. The sequential operation of the various elements of the control system is shown in figure 2-8, the sequential operation chart of the control system. The functional operation of the control system is shown in the control system supplemental function operation chart, figure 2-9. The entire operation of the control system, and its effects, can be followed by referring to the illustrations mentioned above.

(2) CONTROL SYSTEM COMPONENTS. --Operation and characteristics of the individual components of the control system are covered in the instruction books for the major components of the system in which the control component is used.

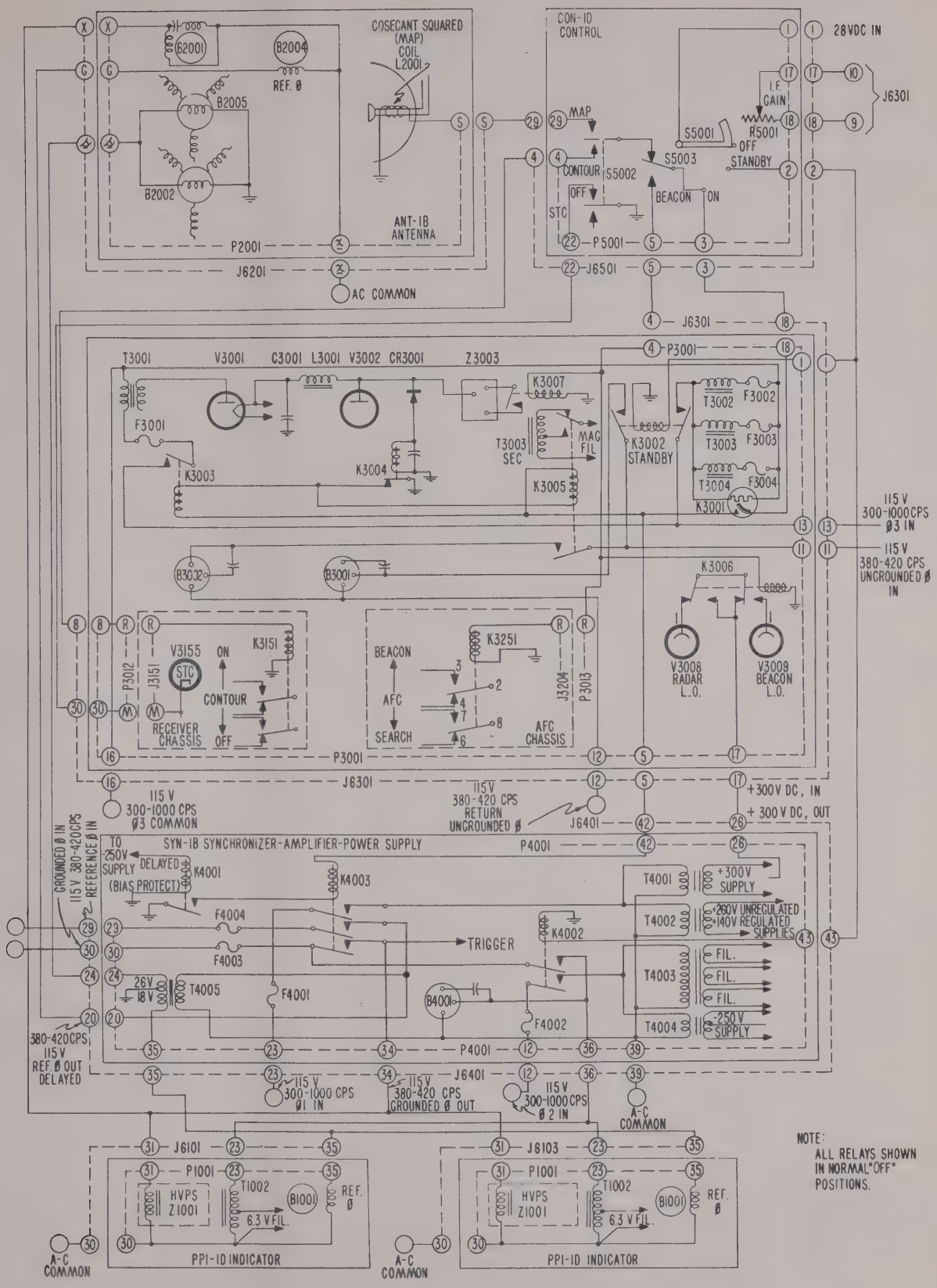
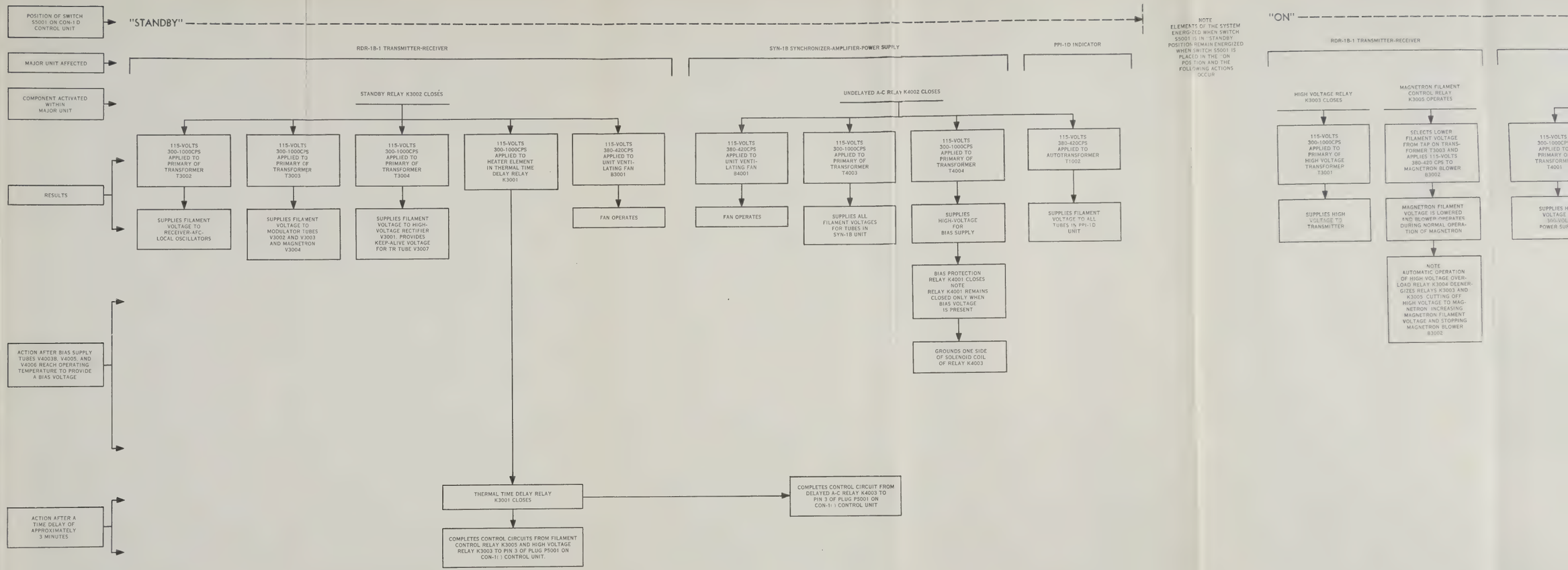


Figure 2-7. RDR-1 (X-band) Airborne Radar Control System, Simplified Schematic Diagram


POSITION OF SWITCH S5001 ON CON-1 D CONTROL UNIT
"STANDBY"
MAJOR UNIT AFFECTED
RDR-1B-1 TRANSMITTER-RECEIVER
SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY
PPI-1D INDICATOR
COMPONENT ACTIVATED WITHIN MAJOR UNIT
STANDBY RELAY K3002 CLOSES
UNDELAYED A-C RELAY K4002 CLOSES
RESULTS
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T3002
SUPPLIES FILAMENT VOLTAGE TO RECEIVER-AFC-LOCAL OSCILLATORS
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T3003
SUPPLIES FILAMENT VOLTAGE TO MODULATOR TUBES V3002 AND V3003 AND MAGNETRON V3004
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T3004
SUPPLIES FILAMENT VOLTAGE TO HIGH-VOLTAGE RECTIFIER V3001. PROVIDES KEEP-ALIVE VOLTAGE FOR TR TUBE V3007
115-VOLTS 300-1000CPS APPLIED TO HEATER ELEMENT IN THERMAL TIME DELAY RELAY K3001
115-VOLTS 380-420CPS APPLIED TO UNIT VENTI-LATING FAN B3001
FAN OPERATES
115-VOLTS 380-420CPS APPLIED TO UNIT VENTI-LATING FAN B4001
FAN OPERATES
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T4003
SUPPLIES ALL FILAMENT VOLTAGES FOR TUBES IN SYN-1B UNIT
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T4004
SUPPLIES HIGH-VOLTAGE FOR BIAS SUPPLY
BIAS PROTECTION RELAY K4001 CLOSES NOTE RELAY K4001 REMAINS CLOSED ONLY WHEN BIAS VOLTAGE IS PRESENT
GROUNDS ONE SIDE OF SOLENOID COIL OF RELAY K4003
115-VOLTS 380-420CPS APPLIED TO AUTOTRANSFORMER T1002
SUPPLIES FILAMENT VOLTAGE TO ALL TUBES IN PPI-1D UNIT
ACTION AFTER BIAS SUPPLY TUBES V4003B, V4005, AND V4006 REACH OPERATING TEMPERATURE TO PROVIDE A BIAS VOLTAGE
ACTION AFTER A TIME DELAY OF APPROXIMATELY 3 MINUTES
THERMAL TIME DELAY RELAY K3001 CLOSES
COMPLETES CONTROL CIRCUITS FROM FILAMENT CONTROL RELAY K3005 AND HIGH VOLTAGE RELAY K3003 TO PIN 3 OF PLUG P5001 ON CON-1( ) CONTROL UNIT.
COMPLETES CONTROL CIRCUIT FROM DELAYED A-C RELAY K4003 TO PIN 3 OF PLUG P5001 ON CON-1( ) CONTROL UNIT
NOTE
ELEMENTS OF THE SYSTEM ENERGIZED WHEN SWITCH S5001 IS IN "STANDBY" POSITION REMAIN ENERGIZED WHEN SWITCH S5001 IS PLACED IN THE "ON" POSITION AND THE FOLLOWING ACTIONS OCCUR
"ON"
RDR-1B-1 TRANSMITTER-RECEIVER
HIGH VOLTAGE RELAY K3003 CLOSES
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF HIGH VOLTAGE TRANSFORMER T3001
SUPPLIES HIGH VOLTAGE TO TRANSMITTER
MAGNETRON FILAMENT CONTROL RELAY K3005 OPERATES
SELECTS LOWER FILAMENT VOLTAGE FROM TAP ON TRANS-FORMER T3003 AND APPLIES 115-VOLTS 380-420 CPS TO MAGNETRON BLOWER B3002
MAGNETRON FILAMENT VOLTAGE IS LOWERED AND BLOWER OPERATES DURING NORMAL OPERA-TION OF MAGNETRON
NOTE
AUTOMATIC OPERATION OF HIGH VOLTAGE OVER-LOAD RELAY K3004 DEENER-GIZES RELAYS K3003 AND K3005 CUTTING OFF HIGH VOLTAGE TO MAG-NETRON INCREASING MAGNETRON FILAMENT VOLTAGE AND STOPPING MAGNETRON BLOWER B3002
115-VOLTS 300-1000CPS APPLIED TO PRIMARY O TRANSFORM T4001
SUPPLIES H VOLTAGE 3KV/VOL POWER SUP

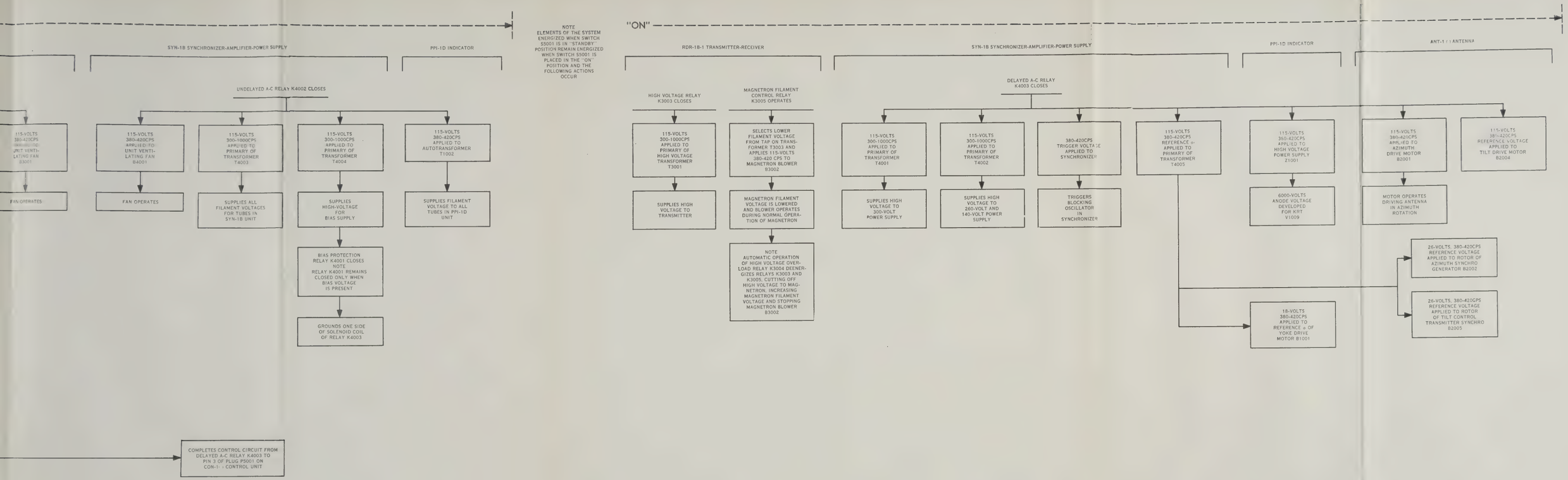

SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY
PPI-1D INDICATOR
UNDELAYED A-C RELAY K4002 CLOSES
115-VOLTS 380-420CPS APPLIED TO UNIT VENTILATING FAN B3001
FAN OPERATES
115-VOLTS 380-420CPS APPLIED TO UNIT VENTILATING FAN B4001
FAN OPERATES
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T4003
SUPPLIES ALL FILAMENT VOLTAGES FOR TUBES IN SYN-1B UNIT
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T4004
SUPPLIES HIGH-VOLTAGE FOR BIAS SUPPLY
BIAS PROTECTION RELAY K4001 CLOSES NOTE RELAY K4001 REMAINS CLOSED ONLY WHEN BIAS VOLTAGE IS PRESENT
GROUNDS ONE SIDE OF SOLENOID COIL OF RELAY K4003
115-VOLTS 380-420CPS APPLIED TO AUTOTRANSFORMER T1002
SUPPLIES FILAMENT VOLTAGE TO ALL TUBES IN PPI-1D UNIT
COMPLETES CONTROL CIRCUIT FROM DELAYED A-C RELAY K4003 TO PIN 3 OF PLUG P5001 ON CON-1 - CONTROL UNIT
NOTE
ELEMENTS OF THE SYSTEM ENERGIZED WHEN SWITCH S5001 IS IN "STANDBY" POSITION REMAIN ENERGIZED WHEN SWITCH S5001 IS PLACED IN THE "ON" POSITION AND THE FOLLOWING ACTIONS OCCUR
"ON"
RDR-1B TRANSMITTER-RECEIVER
SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY
PPI-1D INDICATOR
ANT-1 ( ) ANTENNA
HIGH VOLTAGE RELAY K3003 CLOSES
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF HIGH VOLTAGE TRANSFORMER T3001
SUPPLIES HIGH VOLTAGE TO TRANSMITTER
MAGNETRON FILAMENT CONTROL RELAY K3005 OPERATES
SELECTS LOWER FILAMENT VOLTAGE FROM TAP ON TRANSFORMER T3003 AND APPLIES 115-VOLTS 380-420 CPS TO MAGNETRON BLOWER B3002
MAGNETRON FILAMENT VOLTAGE IS LOWERED AND BLOWER OPERATES DURING NORMAL OPERATION OF MAGNETRON
NOTE
AUTOMATIC OPERATION OF HIGH VOLTAGE OVERLOAD RELAY K3004 DEENERGIZES RELAYS K3003 AND K3005, CUTTING OFF HIGH VOLTAGE TO MAGNETRON, INCREASING MAGNETRON FILAMENT VOLTAGE AND STOPPING MAGNETRON BLOWER B3002
DELAYED A-C RELAY K4003 CLOSES
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T4001
SUPPLIES HIGH VOLTAGE TO 300-VOLT POWER SUPPLY
115-VOLTS 300-1000CPS APPLIED TO PRIMARY OF TRANSFORMER T4002
SUPPLIES HIGH VOLTAGE TO 260-VOLT AND 140-VOLT POWER SUPPLY
380-420CPS TRIGGER VOLTAGE APPLIED TO SYNCHRONIZER
TRIGGERS BLOCKING OSCILLATOR IN SYNCHRONIZER
115-VOLTS 380-420CPS REFERENCE ø APPLIED TO PRIMARY OF TRANSFORMER T4005
18-VOLTS 380-420CPS APPLIED TO REFERENCE ø OF YOKE DRIVE MOTOR B1001
115-VOLTS 380-420CPS APPLIED TO HIGH VOLTAGE POWER SUPPLY Z1001
6000-VOLTS ANODE VOLTAGE DEVELOPED FOR KRT V1009
115-VOLTS 380-420CPS APPLIED TO AZIMUTH DRIVE MOTOR B2001
MOTOR OPERATES DRIVING ANTENNA IN AZIMUTH ROTATION
115-VOLTS 380-420CPS REFERENCE VOLTAGE APPLIED TO TILT DRIVE MOTOR B2004
26-VOLTS, 380-420CPS REFERENCE VOLTAGE APPLIED TO ROTOR OF AZIMUTH SYNCHRO GENERATOR B2002
26-VOLTS, 380-420CPS REFERENCE VOLTAGE APPLIED TO ROTOR OF TILT CONTROL TRANSMITTER SYNCHRO B2005

FIGURE 2-8. RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM SEQUENTIAL OPERATION CHART OF CONTROL SYSTEM

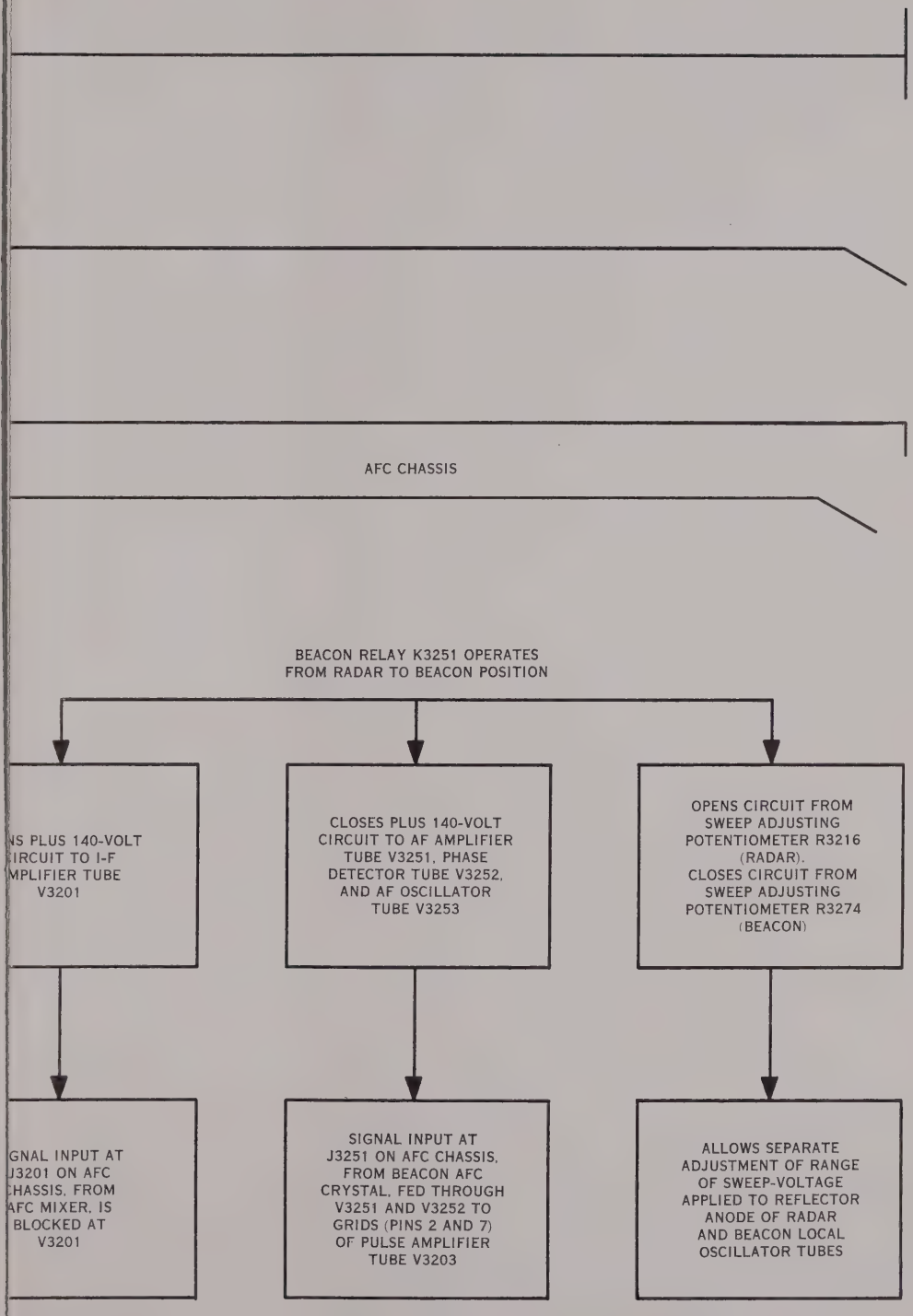

AFC CHASSIS
BEACON RELAY K3251 OPERATES FROM RADAR TO BEACON POSITION
NS PLUS 140-VOLT CIRCUIT TO I-F MPLIFIER TUBE V3201
CLOSES PLUS 140-VOLT CIRCUIT TO AF AMPLIFIER TUBE V3251, PHASE DETECTOR TUBE V3252, AND AF OSCILLATOR TUBE V3253
OPENS CIRCUIT FROM SWEEP ADJUSTING POTENTIOMETER R3216 (RADAR). CLOSES CIRCUIT FROM SWEEP ADJUSTING POTENTIOMETER R3274 (BEACON)
GNAL INPUT AT J3201 ON AFC CHASSIS, FROM AFC MIXER, IS BLOCKED AT V3201
SIGNAL INPUT AT J3251 ON AFC CHASSIS, FROM BEACON AFC CRYSTAL, FED THROUGH V3251 AND V3252 TO GRIDS (PINS 2 AND 7) OF PULSE AMPLIFIER TUBE V3203
ALLOWS SEPARATE ADJUSTMENT OF RANGE OF SWEEP-VOLTAGE APPLIED TO REFLECTOR ANODE OF RADAR AND BEACON LOCAL OSCILLATOR TUBES

FIGURE 2-9. CONTROL SYSTEM SUPPLEMENTAL FUNCTION OPERATION CHART

CONTROL SYSTEM---SUPPLEMENTAL FUNCTIONS---SELECTABLE WHEN SYSTEM IS IN OPERATION---SWITCH S5001 "ON"

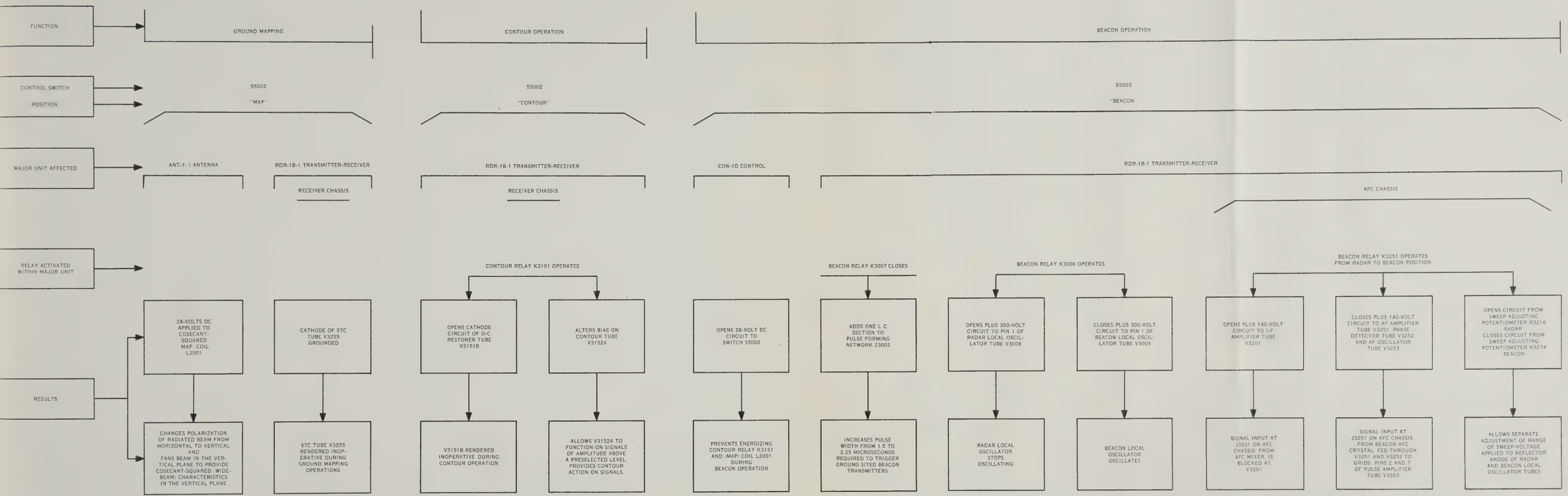

FUNCTION
GROUND MAPPING
CONTOUR OPERATION
BEACON OPERATION
CONTROL SWITCH POSITION
S5002 "MAP"
S5002 "CONTOUR"
S5003 "BEACON"
MAJOR UNIT AFFECTED
ANT-1( ) ANTENNA
RDR-1B-1 TRANSMITTER-RECEIVER
RECEIVER CHASSIS
RDR-1B-1 TRANSMITTER-RECEIVER
RECEIVER CHASSIS
CON-1D CONTROL
RDR-1B-1 TRANSMITTER-RECEIVER
AFC CHASSIS
RELAY ACTIVATED WITHIN MAJOR UNIT
CONTOUR RELAY K3151 OPERATES
BEACON RELAY K3007 CLOSES
BEACON RELAY K3006 OPERATES
BEACON RELAY K3251 OPERATES FROM RADAR TO BEACON POSITION
RESULTS
28-VOLTS DC APPLIED TO COSECANT-SQUARED MAP COIL L2001
CATHODE OF STC TUBE V3255 GROUNDED
OPENS CATHODE CIRCUIT OF D-C RESTORER TUBE V3151B
ALTERS BIAS ON CONTOUR TUBE V3152A
OPENS 28-VOLT DC CIRCUIT TO SWITCH S5002
ADDS ONE L C SECTION TO PULSE FORMING NETWORK Z3002
OPENS PLUS 300-VOLT CIRCUIT TO PIN 1 OF RADAR LOCAL OSCILLATOR TUBE V3008
CLOSES PLUS 300-VOLT CIRCUIT TO PIN 1 OF BEACON LOCAL OSCILLATOR TUBE V3009
OPENS PLUS 140-VOLT CIRCUIT TO I-F AMPLIFIER TUBE V3201
CLOSES PLUS 140-VOLT CIRCUIT TO AF AMPLIFIER TUBE V3251 PHASE DETECTOR TUBE V3252 AND AF OSCILLATOR TUBE V3253
OPENS CIRCUIT FROM SWEEP ADJUSTING POTENTIOMETER R3216 RADAR
CLOSES CIRCUIT FROM SWEEP ADJUSTING POTENTIOMETER R3274 BEACON
CHANGES POLARIZATION OF RADIATED BEAM FROM HORIZONTAL TO VERTICAL AND
FANS BEAM IN THE VERTICAL PLANE TO PROVIDE COSECANT-SQUARED WIDE-BEAM CHARACTERISTICS IN THE VERTICAL PLANE
STC TUBE V3255 RENDERED INOPERATIVE DURING GROUND MAPPING OPERATIONS
V3151B RENDERED INOPERATIVE DURING CONTOUR OPERATION
ALLOWS V3152A TO FUNCTION ON SIGNALS OF AMPLITUDE ABOVE A PRESELECTED LEVEL PROVIDES CONTOUR ACTION ON SIGNALS.
PREVENTS ENERGIZING CONTOUR RELAY K3151 AND (MAP) COIL L2001 DURING BEACON OPERATION
INCREASES PULSE WIDTH FROM 1.5 TO 2.25 MICROSECONDS REQUIRED TO TRIGGER GROUND SITED BEACON TRANSMITTERS
RADAR LOCAL OSCILLATOR STOPS OSCILLATING
BEACON LOCAL OSCILLATOR OSCILLATES
SIGNAL INPUT AT J3201 ON AFC CHASSIS FROM AFC MIXER IS BLOCKED AT V3201
SIGNAL INPUT AT J3251 ON AFC CHASSIS FROM BEACON AFC CRYSTAL FED THROUGH V3251 AND V3252 TO GRIDS PINS 2 AND 7 OF PULSE AMPLIFIER TUBE V3203
ALLOWS SEPARATE ADJUSTMENT OF RANGE OF SWEEP-VOLTAGE APPLIED TO REFLECTOR ANODE OF RADAR AND BEACON LOCAL OSCILLATOR TUBES

FIGURE 2-9. CONTROL SYSTEM SUPPLEMENTAL FUNCTION OPERATION CHART

Figure 2-10. RDR-1 (X-band) Airborne Radar System, Block Diagram

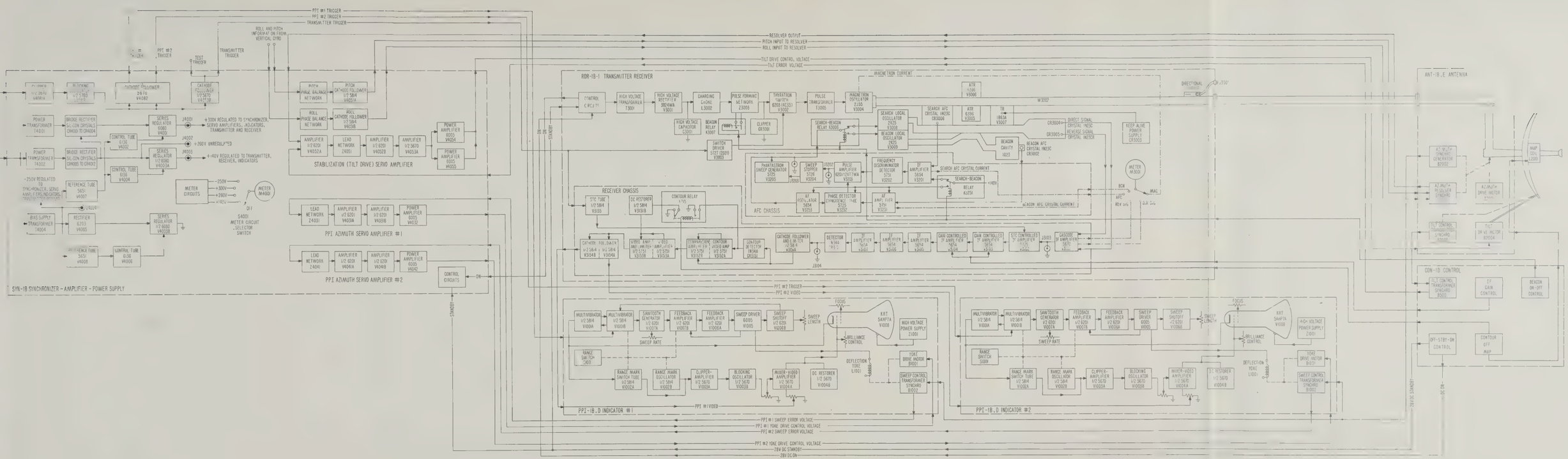

SYN-1B SYNCHRONIZER – AMPLIFIER – POWER SUPPLY
RDR-1B-1 TRANSMITTER RECEIVER
RECEIVER CHASSIS
AFC CHASSIS
STABILIZATION (TILT DRIVE) SERVO AMPLIFIER
PPI AZIMUTH SERVO AMPLIFIER #1
PPI AZIMUTH SERVO AMPLIFIER #2
PPI-1B,D INDICATOR #1
PPI-1B,D INDICATOR #2
ANT-1B,E ANTENNA
CON-1D CONTROL
METER CIRCUITS
METER CIRCUIT SELECTOR SWITCH
PPI #1 TRIGGER
PPI #2 TRIGGER
TRANSMITTER TRIGGER
ROLL AND PITCH INFORMATION FROM VERTICAL GYRO
RESOLVER OUTPUT
PITCH INPUT TO RESOLVER
ROLL INPUT TO RESOLVER
TILT DRIVE CONTROL VOLTAGE
TILT ERROR VOLTAGE
+300V REGULATED TO SYNCHRONIZER, SERVO AMPLIFIERS, INDICATORS, TRANSMITTER AND RECEIVER
+260V UNREGULATED
+140V REGULATED TO TRANSMITTER, RECEIVER, INDICATORS
-250V REGULATED TO SYNCHRONIZER, SERVO AMPLIFIERS, INDICATORS
+28V DC
PPI #1 SWEEP ERROR VOLTAGE
PPI #1 YOKE DRIVE CONTROL VOLTAGE
PPI #2 SWEEP ERROR VOLTAGE
PPI #2 YOKE DRIVE CONTROL VOLTAGE
28V DC STANDBY
28V DC ON

Figure 2-10. RDR-1 (X-band) Airborne Radar System, Block Diagram

SECTION III
INSTALLATION

3-1. GENERAL.

This section contains information and illustrations designed to facilitate the installation of a Bendix Type RDR-1 Airborne Radar System in an aircraft. Initial test and adjustment procedures are included.

3-2. UNPACKING.

The system is supplied with a complete complement of tubes and fuses, installed, and is factory aligned and adjusted. Normal care should be exercised when unpacking this equipment and a complete visual and mechanical check is recommended.

No special unpacking instructions are required, except a caution with respect to ANT-1( ) Antenna.

CAUTION

> It is recommended that the antenna not be removed from its shipping board until it is to be installed in the aircraft. While the antenna is attached to its shipping board, it is less liable to damage through handling.

3-3. INSTALLATION.

a. GENERAL. --Prior to installation of the RDR-1 Airborne Radar System in an aircraft, careful consideration should be given to the placement of the various units of the system to determine locations most suitable for best cabling, easy access for servicing, ventilation, proximity of aircraft junction strips, possible interaction with other equipment, weight distribution, and, with reference to the antenna, structural interference.

The exact mounting position for each unit of the system should be determined before interconnecting cables are run and before the r-f transmission line (waveguide between transmitter and antenna) is installed in the aircraft.

b. LOCATION OF UNITS.

(1) ANTENNA. --The antenna is designed to mount to the forward bulkhead in the nose section of the aircraft, behind a radome fabricated for the operating frequency of the radar system.

The total space required for antennas utilizing reflectors of various diameters may be determined from the dimensional information contained in the antenna outline drawing, figure 3-13.

(2) TRANSMITTER-RECEIVER. --The transmitter-receiver unit is designed for radio rack mounting. It can be mounted in other locations; however, several considerations apply. It is recommended that a total waveguide run, between transmitter and antenna, be held to a maximum of 30 feet. Shockmounting is required and ventilation is important.

The total mounting space required can be determined from the dimensional information contained in the transmitter-receiver outline drawing, figure 3-6.

(3) SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY. --The SYN-1B is also designed for radio rack mounting. Installation of this unit and the transmitter-receiver in a common location facilitates testing, servicing and adjusting, and provides for better cabling. Shockmounting is required and ventilation is important.

The total mounting space required can be determined from the dimensional information contained in the SYN-1B outline drawing, figure 3-8.

(4) INDICATOR. --The RDR-1 Airborne Radar System includes facilities for the use of one or two indicators. The use of a second indicator is optional.

A mounting position, in the cockpit of the aircraft, convenient to the pilot and/or copilot is indicated. A second indicator can also be located in the cockpit or in a location convenient to the navigator. Shockmounting is required and ventilation must be considered.

The total mounting space required can be determined from the dimensional information contained in the indicator outline drawing, figure 3-10.

(5) CONTROL UNIT. --The control unit will ordinarily be used by both the pilot and copilot and should be installed in the cockpit of the aircraft, convenient to both. Shockmounting is not required and ventilation is not important.

The total mounting space required can be determined from the dimensional information contained in the control unit outline drawing, figure 3-11.

c. CABLING. --Cabling diagram (figure 3-3) shows, in simplified block diagram form, all interconnecting cables required to integrate the RDR-1 Airborne Radar System.

Refer to table 1-2 for a list of components required for the fabrication of each individual cable. Note that stranded wire is used throughout. Wire length for each cable will vary depending on the requirements of the individual installation.

The system interconnecting wiring diagram (figure 3-4) contains all essential interconnecting data. Note that all components of the system interconnect at the junction strip in the aircraft. One end of each cable "A" through "F" (figure 3-3) terminates in a jack. The other end of each cable "A" through "F" terminates on a common junction strip in the aircraft where all interunit connections are made. One end of cable "G" terminates on the common junction strip in the aircraft, the other end connects to the output of the aircraft's vertical gyro. (Refer to NOTE 7, figure 3-4 for proper connections to vertical gyro.) One end of all conductors indicated as part of cable "X" (figure 3-3) terminates on the common junction strip, the other end of each conductor connects to the primary power supply sources in the aircraft as indicated in figure 3-4 under "EXTERNAL CONNECTIONS".

Consideration should be given to such measures as will ensure the most satisfactory interunit cabling. Cables should be kept as short as practical, laced securely, properly supported to prevent vibration, and routed to avoid interaction with other equipment. Allow sufficient slack at the ends of cables to facilitate servicing. Avoid sharp bends. The interconnecting-cabling installation must be mechanically and electrically secure.

d. PRIMARY POWER REQUIREMENTS.

(1) GENERAL.--The primary power requirements of the RDR-1 Airborne Radar System are outlined in section I, paragraph 1-6, and in table 1-4.

Connections from the radar set to the various primary power supplies are shown in figure 3-4 under "EXTERNAL CONNECTIONS".

The "INPUT POWER REQUIREMENTS" chart in figure 3-4 shows the various loads (1 through 8) which must be fed by primary power supplies. The chart lists the load numbers (1 through 8), identifies the external connections (A through L), shows type of power required for each load, shows approximate power demand for each load, and includes optional connection data (under "COMMENTS") which show the possibilities of feeding the radar system from various types or combinations of primary power sources which may be encountered in various aircraft.

(2) A-C POWER.--Load numbers 1 to 6, inclusive, require 115 volts ac. While load numbers 1, 2, and 3 are shown to require 115 volts plus or minus 10 per cent, 300-1000 cps, it should be noted that load numbers 1 to 6, inclusive, may be connected to a single source of 115 volts plus or minus five per cent, 400 cps plus or minus five per cent, capable of supplying the total demand of all included loads, if the conditions under "COMMENTS" (figure 3-4, "INPUT POWER REQUIREMENTS" chart) are met.

(3) D-C POWER.--Load 7 and load 8 each require 28 volts dc and, combined draw a maximum of 0.87 ampere. These two loads may be connected to any 28-volt d-c source capable of supplying the maximum demand.

(4) ROLL AND PITCH INFORMATION. --In addition to the requirements of loads 1 to 8, inclusive, the radar set requires roll and pitch output voltages, from the aircraft's vertical gyro, for operation of the stabilization servo system.

It is important that the connections to the vertical gyro outputs be made according to the "CONNECTIONS TO OUTPUT FROM VERTICAL GYRO" diagram and NOTE 7 of figure 3-4.

The stabilization servo system of the RDR-1 Airborne Radar System requires roll and pitch input signals of 50 millivolts per degree at plus 10 degrees to the reference phase (external connection E, figure 3-4). This requirement is met by the Eclipse-Pioneer PB10 and PB10A Automatic Pilot systems; however, if the radar system is installed in aircraft equipped with a Sperry A12 Automatic Pilot system, a step-down isolation transformer must be used in both the roll and the pitch output circuits. One such transformer is the Sperry Isolation Transformer No. 661711 which will reduce the vertical gyro output, of the Sperry A12 Automatic Pilot, to the standard (ARINC) roll and pitch input voltage. For Sperry Automatic Pilot Systems which have been modified to meet the ARINC roll and pitch input specifications, the additional transformers are not required.

If the aircraft is not equipped with an autopilot, a separate vertical gyro will be required. A Bendix Type GYA-1A Stabilization Data Generator is available to meet this need. Figure 3-5 is a simplified schematic of the GYA-1A Stabilization Data Generator (vertical gyro), Bendix part number N221413-2, Junction Box DR-37-A1, Bendix part number N221413-3, and a diagram of the interconnecting wiring essential for its use with the RDR-1 Airborne Radar System.

e. WAVEGUIDE INSTALLATION.

(1) GENERAL. --Each installation will require a means for directing generated pulses of r-f energy from the transmitter to the antenna and also for directing the echo or received signals, intercepted by the antenna, back to the receiver. For this purpose a transmission line, composed of aluminum waveguide

sections, must be installed in the aircraft. The waveguide should be installed in as direct a path as possible between the RDR-1( ) Transmitter-Receiver and the ANT-1( ) Antenna.

NOTE

Waveguide runs between transmitter and antenna should be designed for minimum length to avoid unnecessary attenuation of the radar signal. Runs in excess of 30 feet are not recommended.

Airtron Inc., of Linden, New Jersey, has developed a double-ridge waveguide with dual-frequency range operating characteristics which comply with the specifications of Characteristic #529 Aeronautical Radio Incorporated (ARINC). The use of this waveguide in the aircraft transmission line will permit the installation of either C-band radar equipment or of X-band equipment without performance loss. Besides allowing the interchange of radar equipments, ridge waveguide offers definite size and weight advantages over the installation of standard C-band waveguide and offers higher power rating and lower attenuation factor for X-band use without a major weight penalty. This double-ridged guide is Airtron Type ARA-136 and a catalogue of available standard parts may be obtained from Airtron, Inc.

(2) DESIGN OF WAVEGUIDE INSTALLATION. --The following installation information, as recommended by Airtron, Inc., is provided to enable those who may not be familiar with the problem of installing waveguide in aircraft to devise a transmission line which will provide proper performance. During the design of the transmission line installation it is desirable to mock up the components in the actual aircraft or in the aircraft mock up. The use of standard parts in the transmission line design is most desirable. If special parts must be used to solve installation problems, the exact configuration of these parts should be carefully determined during the mock up. When a satisfactory mock-up system has been designed, a drawing or sketch of this system in line form

should be made to help describe the complete list of parts to be ordered. Such a drawing should indicate the length and standard part numbers of the component sections of waveguide and should identify special nonstandard components. External drawings or sketches with sufficient dimensioning to completely define the part should be submitted when ordering nonstandard waveguide components.

The following points should be observed in the use of rigid waveguide components in ridge-guide transmission line design:

Use standard rigid components wherever possible.

Minimize the number of joints in the waveguide run. Increasing the total number of joints in the transmission line usually must result in a higher overall VSWR value.

Clamp rigid waveguide to a solid portion of the aircraft structure at least once in each three feet of waveguide run.

Use clamps so designed that they will not distort the waveguide walls.

Before ordering nonstandard large radius waveguide bends, see if the same result can be obtained by using standard bends with additional length in the straight sections.

When specifying unavoidable special bends in rigid waveguide, use an exact radius of 2.214 inches to the waveguide centerline for all sharp bends in either E or H plane and seven inches centerline radius or greater in large bends.

Each individual section of rigid waveguide should contain no more than one bend. This procedure simplifies maintenance of the transmission line.

Remember to allow sufficient clearance to permit access to flange connecting screws.

Use waveguide quick disconnects wherever joints are to be broken repeatedly for maintenance, inspection, or access to other equipment, or to assure good joint sealing in relatively inaccessible locations. Quick disconnects avoid stripped threads in the aluminum waveguide flanges and assure proper joint sealing under the most adverse conditions of assembly.

Be certain that each joint in the waveguide run is made by the mating of a gasket flange and a cover flange. This type joint will permit proper rf and pressure sealing of the line. Each waveguide section should have a gasket flange and a cover flange at its opposite ends, where possible. Carefully avoid specifying nonstandard flanges, such as gasket flanges with tapped screw holes.

Axial twists in rigid waveguide, up to 90 degrees, should be considered as being made in approximately an eight-inch length of waveguide. Before specifying twists in rigid waveguide, make certain that the same result cannot be more easily accomplished by properly oriented bends in a section of flexible waveguide.

The following points should be observed in the use of flexible waveguide components in ridge guide transmission line design:

Use standard flexible components wherever possible.

Minimize the number of joints in the waveguide run.

Locate a flexible section at the points of attachment to the antenna unit and the RT unit. (Usually connected after the adapter used directly on the RT unit connection.) These sections will provide vibration isolation between the rigidly mounted transmission line and the radar units.

Use standard flexible sections for providing expansion joints or vibration isolation in the transmission line and in positions where the installation or removal of rigid waveguide would be exceedingly difficult.

Flexible waveguide should be used instead of rigid sections containing complex bends wherever possible. Compound bends and apparent twists can be obtained through the use of flexible waveguide, usually at lower cost and with some simplification of installation.

In any single installation, attempt to use the same length of flexible waveguide for all flexible sections of the transmission line. Preferred lengths for flexible sections are 8.25, 12, 14, 22, 24 inches.

Clamp flexible waveguide firmly to a solid portion of the aircraft structure at least once in each 18 inches of waveguide run.

Design flexible waveguide clamps carefully so that they do not distort the waveguide walls.

Where flexible waveguide must be pressure sealed during passage through a bulkhead, write Airtron for latest information on pressuretight bulkhead feedthrough assemblies.

Use waveguide quick disconnects wherever joints are to be broken repeatedly or to assure good joint sealing in relatively inaccessible locations.

Use flexible waveguide to produce the same effect as a twist in rigid waveguide components. Any combination of two alternate (right and left) 90-degree bends in either the E or H plane (broad or narrow wall) with any 90-degree bend in the opposite plane between them will produce an effective waveguide twist. Such flexible components are less expensive and more easily installed than rigid twists.

Figure 3-1 illustrates several standard double-ridged waveguide components: A is a straight section illustrating the E and H planes of the waveguide; B illustrates a 90-degree bend in the E plane; C illustrates a 45-degree bend in the H plane; D shows dimensions of standard flange connectors and illustrates both a plain, or cover, flange and a gasket flange; E illustrates one type of feedthrough which may be used to connect the waveguide through a pressurized bulkhead.

f. ANTENNA INSTALLATION.

(1) GENERAL.--The antenna must be installed in the nose section of the aircraft in front of the forward bulkhead. It may be mounted to the forward bulkhead by using the extension mounting bracket (4, figure 3-2), or special brackets may be designed and fabricated by the user to allow antenna installation to be made under unusual mounting conditions. Versatility of mounting is increased by the inclusion of two tapped mounting holes in each side of the antenna

scanner body (1, figure 3-2) to accommodate rail mounting or support; the five optional positions of the waveguide input flange (2) (see also figure 3-13); and the option of mounting the antenna in either an upright or inverted position. Inverted mounting requires internal wiring changes as outlined in paragraph 3-3f(4).

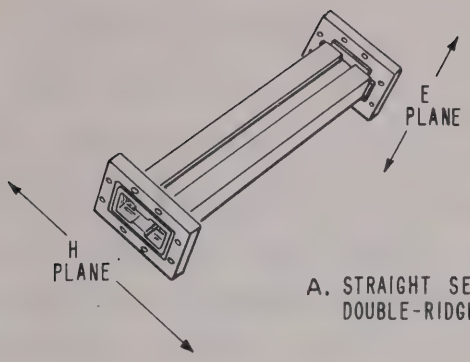
The ANT-1( ) Antenna is designed to rotate from right to left when viewed facing the reflector. The unit is wired for proper rotation, synchronization, and stabilization when mounted in the aircraft with the mounting bracket above the reflector. In some installations it may be necessary or advantageous to mount the antenna in an inverted position; that is, with the reflector above the mounting bracket. When this condition prevails, modifications to the wiring of the antenna will be necessary to maintain proper rotation, synchronization, and stabilization.

Refer to paragraph 3-3f(4) when these modifications are necessary.

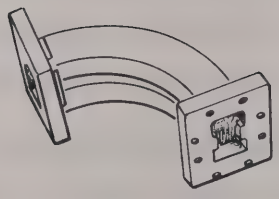
(2) SHOCKMOUNTING AND VENTILATION. --Shockmounting is not required. The antenna is designed to operate in the unpressurized nose section of aircraft and ventilation is not important.

(3) ORIENTATION. --The mounting position of the antenna must satisfy the following conditions: Centerline of antenna feed (10, figure 3-2) must be located at aircraft centerlines (6) or within three inches below horizontal centerline on vertical centerline; azimuth spin axis of antenna (9) must parallel spin axis of the stabilizing vertical gyro; tilt axis of antenna (8) must parallel pitch axis of aircraft. This should result in the azimuth spin axis of the antenna (9) lying mutually perpendicular to the roll and pitch axis of the aircraft.

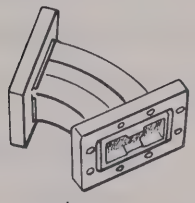
To ensure that targets are displayed in their proper relative positions with respect to the aircraft, the radar beam must radiate forward, perpendicular to the pitch axis of the aircraft, and in the plane of flight path when the antenna is positioned at zero degrees in both azimuth and tilt.



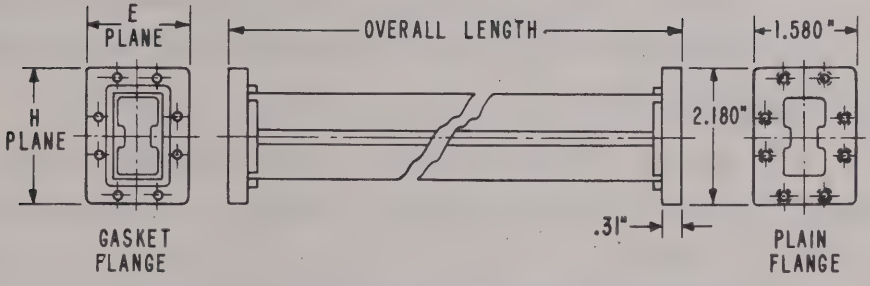
A. STRAIGHT SECTION OF DOUBLE-RIDGE WAVEGUIDE.



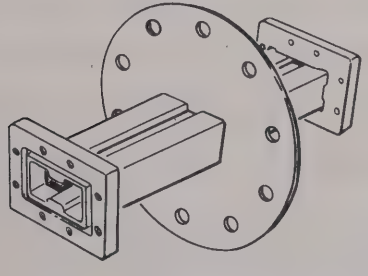
B. SECTION OF DOUBLE-RIDGE WAVEGUIDE BENT IN E PLANE (90 DEGREE BEND).



C. SECTION OF DOUBLE-RIDGE WAVEGUIDE BENT IN H PLANE (45 DEGREE BEND).



D. FLANGE TYPES AND DIMENSIONS OF DOUBLE-RIDGE WAVEGUIDE FOR OPERATION IN C-BAND (5.7 CM) OR X-BAND (3.2 CM).



E. PRESSURIZED BULKHEAD FEEDTHROUGH ASSEMBLY, DOUBLE-RIDGED WAVEGUIDE.

L614740

Figure 3-1. Examples of Double-Ridged R-F Waveguide Sections

The antenna stabilization system will function properly only when the azimuth spin axis of the antenna parallels the spin axis of the stabilizing vertical gyro. Should an ambiguity exist between the two spin axes, an inherent error is developed in the system. This error is evidenced by uneven azimuth illumination of terrain as the antenna revolves. This condition is undesirable and may cause some confusion when interpreting the radar display; therefore, it is important that the antenna and gyro spin axis be in coincidence (both pitch and roll planes) when the antenna is being mounted. The same reference criterion for mounting the gyro should be employed for leveling and mounting the antenna.

(4) MODIFICATIONS FOR INVERTED MOUNTING. --When it is necessary to mount the antenna in an inverted position, that is, with the reflector above the antenna scanner housing, the following procedure should be followed to accomplish the necessary modifications before installing the antenna.

Step 1. Remove the six screws from the antenna scanner housing top cover, and remove top cover to expose terminal boards TB2001 and TB2002 within the housing.

Step 2. Remove the four screws from the terminal board cover above the tilt control transmitter synchro B2005 and remove the cover to expose terminal board TB2003.

Step 3. Interchange the red and natural-colored leads, from the azimuth drive motor B2001, at terminals 1 and 2 of terminal board TB2001.

Step 4. Interchange the blue and yellow stator leads, from the azimuth synchro generator B2002, at terminals 5 and 6 of terminal board TB2001.

Step 5. Interchange the blue and yellow leads, from the azimuth resolver B2003, at terminals 6 and 7 of terminal board TB2002.

Step 6. Interchange the blue and yellow stator leads, from the tilt control transmitter synchro B2005, at terminals 4 and 5 of terminal board TB2003.

Step 7. Interchange the No. 1 red lead on terminal 1 with the No. 2 black lead on terminal 2 of terminal board TB2003. Leave the No. 1 black lead on terminal 1. The two leads interchanged are rotor leads from the tilt control transmitter synchro B2005.

Step 8. Reinstall cover on terminal board TB2003.

Step 9. Reinstall top cover on antenna scanner housing.

NOTE

When the antenna is mounted in the aircraft, the spoiler grid attached to the parabolid reflector must be located above the antenna feed. To accomplish this the spoiler grid must be rotated 180 degrees from its present position on the reflector. The reflector is supplied with a duplicate set of grid mounting holes, properly spaced, to facilitate this modification.

Step 10. Note spacing between grid and reflector and location of spacers.

Step 11. Remove spoiler grid from reflector by removing the six sets of hardware holding it in place.

Step 12. Rotate spoiler grid 180 degrees around antenna feed and secure it to reflector with the same hardward and spacers removed in step 11. Make certain that spacers are properly positioned to insure the same spacing between grid and reflector as noted in step 10.

(5) WAVEGUIDE (R-F) CONNECTION. --The waveguide input flange (2, figure 3-2), shown oriented to the rear of the antenna scanner housing, can be oriented 45 degrees and 90 degrees to the right or left of the position shown. (See detail A, figure 3-2.) The five optional positions allow r-f connection to the antenna to be made from as many angles and help simplify the aircraft waveguide installation.

NOTE

When the transmission line in the aircraft is composed of other than type RG-67/U rectangular waveguide, proper transistions must be employed between the antenna r-f input connector and the transmission line.

To change the input angle of the waveguide input flange, it is only necessary to remove the four screws from the top of the rotary joint cover (detail A, figure 3-2); turn the waveguide input flange to the desired 45- or 90-degree angle without lifting the cover; align the screw holes in the housing, shims, and cover; and replace the screws.

(6) ELECTRICAL CONNECTIONS. --All electrical connections to the antenna, except r-f, are made through receptacle P1001, a type AN-3102A-36-7P connector, mounted on the rear of the antenna scanner housing. The mating plug required can be either a type AN-3106-36-7S straight connector, or a type AN-3108-36-7S angle (90-degree) connector.

(7) PRESSURIZATION. --The antenna is designed to operate with internal waveguide air pressures from sea level to 16,000 feet. The mechanical design of the rotating joint in the antenna is such that it restricts air leakage to less than two cubic inches per minute when the pressure differential between the inside and outside of the waveguide is one atmosphere.

Air is bled into the waveguide installation, through a small hole in the spring-loaded waveguide adaptor on the transmitter shockmount, maintaining the air pressure within the waveguide installation at cabin pressure.

Since the antenna is installed in the nose section of the aircraft, which is not normally pressurized, the antenna is designed to operate at external pressures from sea level to 40,000 feet. To prevent air leakage between the pressurized cabin and an unpressurized nose section, the electrical (operating) and r-f transmission lines feeding the antenna must be brought into the nose section of the aircraft, utilizing airtight seals at the bulkhead feedthrough.

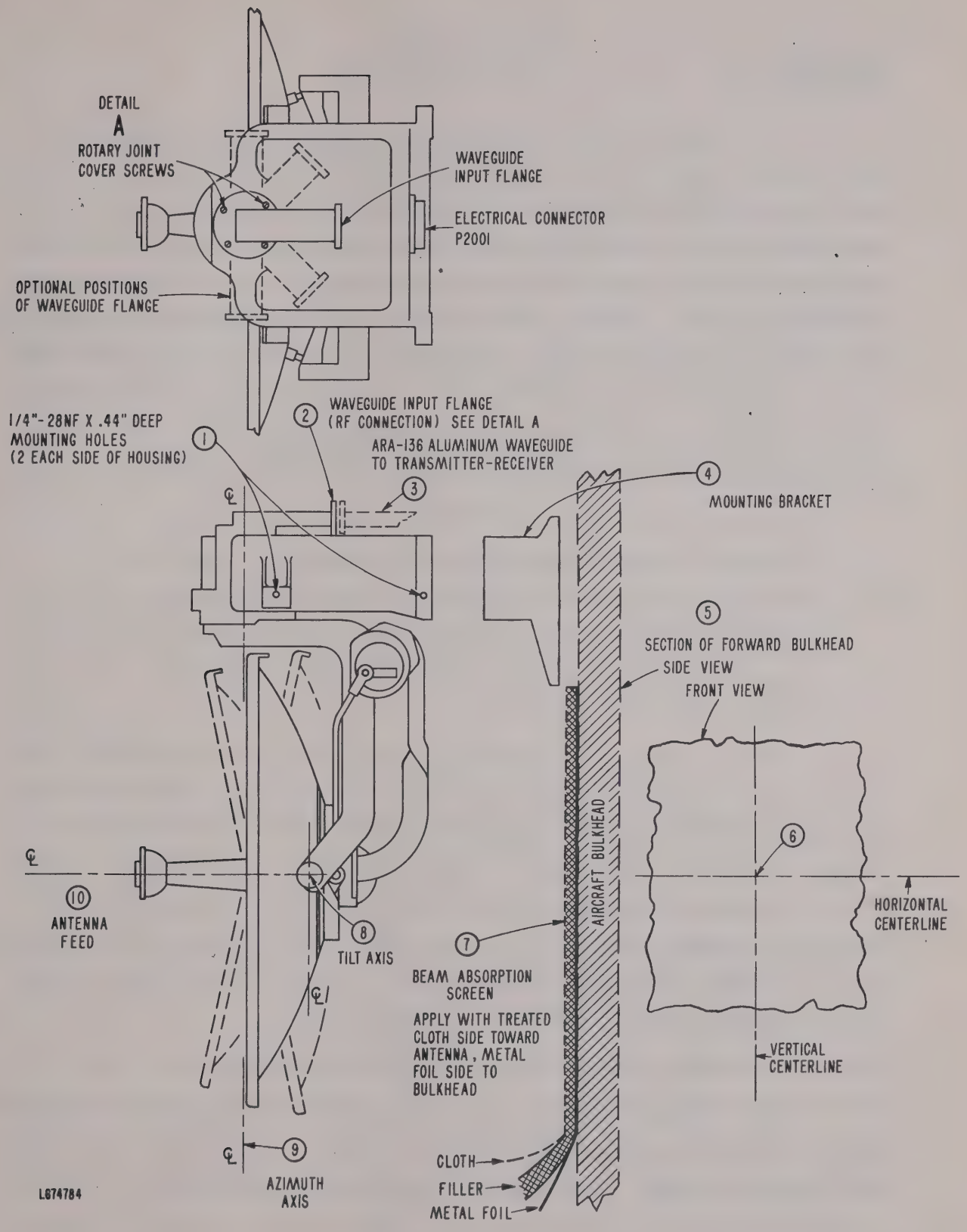


Figure 3-2. Antenna Mounting Data, Referenced Detail Drawing

(8) BEAM ABSORPTION SCREEN.--During a portion of the 360-degree azimuth rotation of the antenna the radiated beam will be directed at various metal surfaces in the nose section of the aircraft. These metal surfaces have undesirable effects on the radar set and must be covered with a beam absorption material such as the type T-XJ-2 absorption screen which is available from the McMillan Supply Co., Ipswich, Mass. This is a mat-type material approximately 5/32-inch thick designed for high attenuation and low reflection of X-band (9375 mc, 3.2 cm) radar beams impinging upon it. This material, or its equivalent, must be applied to all surfaces in the nose section of the aircraft, which are swept by the radar beam, except the radome. (See 7, figure 3-2.)

CAUTION

The beam absorption screen has one treated cloth surface and one metal foil surface. The metal foil surface must be applied next to the bulkhead and any other aircraft surface it is to cover. The treated cloth surface must face the antenna. (See 7, figure 3-2.)

(9) RADOME.--To maintain the aerodynamic characteristics of the aircraft and yet allow satisfactory radar beam radiation through the nose of the aircraft, a portion of the nose section skin and frame, must be replaced with a "radome" having the same general configuration as the nose section it replaces. The radome must be fabricated for X-band (9375 mc, 3.2 cm) signals. Most satisfactory radome installation will allow widest possible angle of beam rotation, up to 240 degrees (120 degrees to each side of aircraft heading), before configuration of aircraft causes interference. (See figure 4-1.)

g. INITIAL ADJUSTMENTS AND TESTS OF ANTENNA.

(1) GENERAL.--The antenna is completely adjusted at the factory and should need no further adjustments before installation, except as noted in paragraph 3-3f(4), however, the following checks should be made before installation.

(2) PREINSTALLATION TEST.

Step 1. Manually rotate the antenna on its azimuth axis, 360 degrees or more, to determine that no binding exists at any azimuth position.

Step 2. Manually tilt the antenna's reflector up and down to its extreme tilt positions to determine that no binding exists at any position of tilt within the mechanically restricted tilt limits. DO NOT FORCE against action of spring-loaded mechanical stops.

(3) POST INSTALLATION TEST. --After the antenna has been completely installed and absorption screen material has been applied to all necessary surfaces in the nose section of the aircraft, perform the following tests:

Step 1. Manually rotate antenna 360 degrees at zero tilt angle and at maximum tilt angles above and below the normal zero tilt angle to determine that proper clearance has been provided for every position of the antenna.

Step 2. Check to see that all electrical connections to the antenna are secure.

NOTE

Do not install radome until after complete system has been installed and operationally checked out.

h. RDR-1B-1 TRANSMITTER-RECEIVER INSTALLATION.

(1) GENERAL. --The RDR-1B-1 Transmitter-Receiver can be mounted on a Type SHK-1A Shockmount, available for this purpose, or it can be mounted directly on a standard aircraft vibration rack. The total space required for this unit can be determined from the dimensional information contained in the transmitter-receiver outline drawing, figure 3-6, and the SHK-1A Shockmount outline drawing, figure 3-7.

(2) SHOCKMOUNTING AND VENTILATION. --Shockmounting is required and ventilation is important. At least one inch of free space must be

allowed to the rear of the air exhaust port; the air intake filter on the front panel must be unobstructed; and space to the sides and top of the unit must be allowed for total excursions of the unit in three planes, as allowed by the SHK-1A Shockmount when used.

(3) R-F CONNECTION. --The r-f connector on the rear of the RDR-1B-1 Transmitter-Receiver is a choke flange which mates with a plain flange connector on Shockmount SHK-1A.

The SHK-1A Shockmount features a push-pull quick disconnect which is a spring-loaded, X-band waveguide adaptor with two locating pins and a plain contact flange to mate with the choke flange on the transmitter-receiver. This provides a mechanically and electrically secure r-f connection when the transmitter-receiver is mounted in the shockmount. The other end of the waveguide adaptor on the shockmount is a choke flange designed to mate with a plain flange terminating one end of the waveguide installation in the aircraft.

NOTE

When the transmission line in the aircraft is composed of other than type RG-67/U rectangular waveguide, proper transitions must be employed between the waveguide adaptor on the shockmount and the transmission line.

A section of flexible waveguide should be used between the rigid waveguide installation in the aircraft and the waveguide adaptor on the shockmount. This will provide vibration isolation between the rigidly mounted transmission line and the shockmounted unit.

(4) ELECTRICAL CONNECTIONS. --All electrical connections, except r-f, are made through plug P3001 on the rear of the transmitter-receiver unit. Plug P3001 mates with jack J6301, a type DPD-A-32C2-33S-L connector, on the SHK-1A Shockmount. Jack J6301 terminates interconnecting cable A (figure 3-3).

Shockmount SHK-1A is provided with four grounding straps firmly attached to the shockmount frame, one at each of the four vibration dampers. When mounting the shockmount in the aircraft, the grounding straps must provide electrical bonding between the aircraft frame and the shockmount base. This is usually accomplished by securing the free end of each strap under one of the four mounting holes in each vibration damper. The metal surface to which the shockmount is secured must necessarily be bonded to the aircraft frame. This automatically grounds the transmitter-receiver unit when it is on the shockmount.

i. SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY INSTALLATION

(1) GENERAL. --The SYN-1B Synchronizer-Amplifier-Power Supply can be mounted on a Type SHK-1D Shockmount, available for this purpose, or it can be mounted directly on a standard aircraft vibration rack. The total space required for this unit can be determined from the dimensional information contained in the SYN-1B outline drawing, figure 3-8, and the SHK-1D outline drawing, figure 3-9.

(2) SHOCKMOUNTING AND VENTILATION. --Shockmounting is required and ventilation is important. At least one inch of free space must be allowed to the rear of the air exhaust port; the air intake filter on the front panel must be unobstructed; and space to the sides and top of the unit must be allowed for the total excursions of the unit in three planes, as allowed by the SHK-1D Shockmount when used. A round knock-out panel on the bottom of the SYN-1B case may be removed to utilize forced-air cooling of the unit when such facility is available in the aircraft.

(3) ELECTRICAL CONNECTIONS. --All electrical connections are made through plug P4001 on the rear of the SYN-1B. Plug P4001 mates with jack J6401, a type DPD-45-33S-L connector, on the SHK-1D Shockmount. Jack J6401 terminates interconnecting cable B (figure 3-3). SHK-1D Shockmount requires the same electrical bonding as the SHK-1A Shockmount used for the RDR-1B-1 Transmitter-Receiver.

j. PPI-1B, 1D INDICATOR INSTALLATION.

(1) GENERAL. --Each PPI-1( ) Indicator is equipped with two wrap-around mounting brackets, each consisting of a U-shaped section and a straight channel section bolted thereto. Each straight channel section has two mounting holes for vibration dampers (to be provided by customer as required). Brackets are not fixed to unit and can be oriented to allow unit mounting in any desired position.

The total space required for this unit can be determined from the dimensional information contained in the PPI-1D outline drawing, figure 3-10. Space allowance should be made for use of the detachable viewing hood which is a part of the indicator.

CAUTION

Before the indicator is permanently mounted in a selected location, determine, by actual operation, that no magnetic interference exists between the indicator and other aircraft instruments.

(2) SHOCKMOUNTING AND VENTILATION. --Shockmounting is required and ventilation is important. Adequate shockmounting must be provided. If the mounting brackets supplied are used, four vibration dampers must be attached thereto. If selected location for indicator requires special mounting facilities, vibration dampers must be included in the design.

The perforated rear section of the indicator chassis cover allows unit ventilation by convection. The free flow of air through this perforated cover section must not be obstructed when the indicator is mounted in its operating position.

(3) ELECTRICAL CONNECTIONS, PPI-1B INDICATORS. --All electrical connections to PPI-1B Indicators are made through plug P1001 which terminates a pendant cable from each indicator used.

In installations utilizing either one or two indicators, plug P1001, of indicator No. 1, mates with jack J6101, a type FK-37-21C-5/8 connector, which terminates interconnecting cable D (figure 3-3).

In installations utilizing two indicators, plug P1001, of indicator No. 2, mates with jack J6103, a type FK-37-21C-5/8 connector, which terminates interconnecting cable E (figure 3-3).

NOTE

The pendant cable attaches to a terminal board on the indicator through a square, terminal board cover on the rear of the unit. This cover can be oriented to allow the pendant cable to emerge in any one of four positions, each 90 degrees apart.

(4) ELECTRICAL CONNECTIONS, PPI-1D INDICATORS. --PPI-1D Indicators feature a video input connector (P1002, a type UG-1094/U) separate from the common electrical connector (P1001, a type FK-37-32S). Connectors are mounted directly on the rear cover of the indicator; no pendant cable is supplied.

In installations utilizing one or two indicators, plug P1001, of indicator No. 1, mates with jack J6101, a type FK-37-23-1B connector, and plug P1002 mates with jack J6102, a BNC type UG-260/U connector. Jacks J6101 and J6102 terminate interconnecting cable D (figure 3-3).

In installations utilizing two indicators, plug P1001, of indicator No. 2, mates with jack J6103, a type FK-37-23-1B connector, and plug P1002 mates with jack J6104, a BNC type UG-260/U connector. Jacks J6103 and J6102 terminate interconnecting cable E (figure 3-3).

k. CON-1( ) CONTROL INSTALLATION.

(1) GENERAL. --The CON-1D Control is designed for panel mounting and utilizes four screwdriver-operated Dzus fasteners to secure the unit to the

panel. Size and mounting dimensions are shown in the outline drawing, figure 3-11. Shockmounting is not required and ventilation is not important.

(2) ELECTRICAL CONNECTIONS. --All electrical connections to the CON-1D Control are made through plug P5001 on the rear of the unit. Plug P5001 mates with jack J6501, a type DC-37-S Cannon connector, which terminates cable C (figure 3-3).

1. CON-1K CONVERSION KIT INSTALLATION.

(1) GENERAL. --The CON-1K Conversion Kit can be used to partially replace the CON-1D Control in those installations where space will not permit the use of a standard control unit. Figure 3-12 lists the parts included in the kit, shows mounting dimensions, and contains a detail drawing of panel calibrations for degrees of manually set antenna tilt.

The parts need not occupy the relative positions shown in figure 3-12, but can be installed in available space convenient to the operator.

If the CON-1K Conversion Kit is used in place of the CON-1D Control, two additional toggle switches will be required. The first, a single-pole double-throw toggle switch, will replace BEACON switch S5003. The second, a double-pole double-throw toggle switch with neutral center position, will replace CONTOUR-MAP switch S5002.

(2) ELECTRICAL CONNECTIONS. --All electrical connections must be made in accordance with those shown in the schematic diagram of the CON-1D Control, drawing No. OC670677, included in section IX, and the over-all system wiring diagram, figure 3-4.

3-4. TEST OF INSTALLATION.

a. GENERAL. --After the complete radar system has been installed in an aircraft, several mechanical and electrical tests should be made, prior to the application of any power to the system.

b. MECHANICAL TESTS. --Manually rotate antenna through 360 degrees at zero-degree tilt angle and at maximum tilt angles above and below the normal zero-degree tilt angle to determine that proper antenna clearance has been provided. No rotating part of antenna should snag absorption screen material nor touch any part of the aircraft frame.

Check the mounting of each major component for mechanical security.

Check total possible excursion of shockmounted components to determine that sufficient clearance has been provided.

Check entire waveguide installation for secure, vibrationless mounting and tight connections at all joints.

Check each unit of the system for general mechanical security of all hardware, knobs, and cases.

c. ELECTRICAL TESTS, STATIC. --With all units of the radar system electrically disconnected, make a continuity test of the entire interconnecting wiring installation, using the system wiring diagram (figure 3-4) as a guide.

With antenna connected to the waveguide installation, test the entire waveguide run, including antenna, for total VSWR. This must be done with the antenna pointing into free space to avoid the possibility of reflective target interference. The total VSWR will be the result of many factors in the waveguide and antenna, and a long waveguide run may tend to increase it; therefore, a short run is more desirable. Ratios as high as 1:1.5 have been experienced without noticeably disturbing the system operation; however, a lower VSWR is desirable.

d. GROUND OPERATIONAL TEST PROCEDURE. --Reference is made at this point to the simplified schematic of the control system (figure 2-7), to the control system sequential operations chart (figure 2-8), and to the control system supplemental function operation chart (figure 2-9). These three illustrations will enable the operator to follow the action initiated by any operational control of the system. It is suggested that these illustrations be used throughout this

procedure if it is desired to thoroughly check the actions of those individual components which are not specifically called out in the following over-all system check.

Should any part of the radar system fail to meet any of the conditions of the following operating checks, do not continue with further checks until the cause of failure has been determined and corrected. Section VI of the instruction book for each major component contains the information necessary for the test, repair, and alignment of the individual major component; however, if the trouble is interunit, the system wiring diagram (figure 3-4) should be used as a guide to trace the trouble.

WARNING

Voltages which are dangerous to life are present in this equipment. Personnel are cautioned to observe all safety precautions and regulations at all times.

(1) POSITION OF CONTROLS BEFORE STARTING EQUIPMENT.--Place all controls in the positions listed below before applying power to equipment.

CONTROL	CONTROL POSITION
CON-1( ) CONTROL:	
OFF-STBY-ON switch	OFF
ANT-TILT control	Zero degree
I-F GAIN control	Counterclockwise
DIMMER control	Counterclockwise
CONTOUR-MAP switch	OFF (neutral center)
BEACON switch	OFF
RDR-1( ) TRANSMITTER-RECEIVER:	
METER CIRCUIT SELECTOR switch	OFF

CONTROL	CONTROL POSITION
PPI-1( ) INDICATOR:	
DIMMER control	Counterclockwise
RANGE & MARKS switch	Any
BRILLIANCE control	Counterclockwise
ANT-1( ) ANTENNA:	
AZ (azimuth drive motor) switch	OFF
(Remove cotter pins from both switches)	
EL (tilt drive motor) switch	OFF
SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY:	
METER CIRCUIT SELECTOR switch	-250

(2) TEST PROCEDURE.

CAUTION

Tests involving the radiation of r-f energy by the antenna MUST NOT be made while the antenna is directed toward close-by large metal objects such as hangars or doors. If tests must be made inside a hangar, place a large area of absorption screen material in the beam path of the antenna. This will prevent undesirable interference with the tests and will protect the signal crystals in the radar from possible damage by strong reflected signals.

Step 1. Turn the OFF-STBY-ON switch S5001, on the CON-1( ) Control, to the STBY (stand-by) position and check that the following actions occur:

The RDR-1( ) Transmitter-Receiver unit ventilating fan should operate to exhaust air from the unit.

The SYN-1B Synchronizer-Amplifier-Power Supply unit ventilating fan should operate to exhaust air from the unit.

Step 2. Remove HV (high-voltage) fuse F3001 from its holder on the front panel of the RDR-1( ) Transmitter-Receiver. This will prevent the development of high voltage in the transmitter, the operation of which is not desired during the following steps. Check panel meter on SYN-1B unit for a half-scale reading indicating presence of -250-volt bias.

Step 3. Allow enough time (approximately three minutes) for thermal time-delay relay K3001, in the RDR-1( ) Transmitter-Receiver, to close; then turn OFF-STBY-ON switch S5001 to the ON position and check that the following action occurs:

NOTE

Thermal relay may require more than three minutes for positive closing. If high voltages do not immediately appear when switch S5001 is placed in the ON position, switch back to STBY position and wait another minute before again switching to ON.

Magnetron blower B3002, in the RDR-1( ) Transmitter-Receiver, should operate. This can best be determined by listening near the unit while switch S5001 is turned alternately to the ON and STBY positions. Then leave switch S5001 in the ON position.

Step 4. Turn meter selector switch S4001, on the SYN-1B Synchronizer-Amplifier-Power Supply, to the +140-volt, +260-volt, +300-volt, and -250-volt positions, consecutively, and note reading on panel meter S4001. Meter should read half-scale (0.5 milliampere) for each of the above switch positions. Then return switch S4001 to the OFF position.

NOTE

The vertical gyro in the aircraft should NOT be operating during the following steps.

Step 5. Place the AZ (azimuth drive motor) switch S2001, on the ANT-1( ) Antenna, in the ON position. The antenna reflector and feed assembly should rotate in a clockwise direction; that is, from right to left, when viewed facing the reflector, and at a speed of 15 rpm plus or minus 3 rpm.

Step 6. Place switch S2001 in the OFF position. Rotation should cease.

Step 7. Manually rotate reflector dead ahead as indicated by the alignment of the azimuth zero-degree reference lines on the antenna, and secure in this position. A strip of masking tape may be used to secure the reflector in its zero-degree azimuth position, but the method used must not restrict the reflector's free movement on its tilt axis.

Step 8. Place the EL (tilt drive motor) switch S2002 on the ANT-1( ) Antenna, in the ON position. The reflector should assume its zero-degree tilt position if the ANT-TILT control knob, on the CON-1( ) Control, is still indicating zero.

The zero-tilt position of the antenna can be checked through the plastic synchro drive gear-housing cover by checking that the zero-degree tilt index lines are aligned. DO NOT readjust the tilt index lines if they are not aligned at this time. This tilt adjustment has been carefully aligned at the factory and any misalignment at this time is probably due to some other fault in the system.

Step 9. Rotate ANT-TILT control knob, on the CON-1( ) Control, to indicate 15 degrees UP. Antenna reflector should tilt UP approximately 8.6 degrees (mechanical) [plus 15 degrees (electrical) as indicated by calibrated tilt index lines].

Step 10. Rotate ANT-TILT control knob to indicate 15 degrees DOWN. Antenna reflector should tilt DOWN approximately 8.6 degrees (mechanical) [minus 15 degrees (electrical) as indicated by calibrated tilt index lines].

Step 11. Rotate ANT-TILT control knob to again indicate zero-degree tilt. Antenna reflector should again assume zero-tilt alignment.

NOTE

For the following tests the aircraft's vertical gyro must be operating and erect with respect to the earth's gravitational field. The ANT-TILT control knob must indicate zero-degree tilt.

Step 12. If the longitudinal axis of the aircraft is other than horizontal, note the angle of difference as, nose-UP x-degrees, or nose-DOWN x-degrees.

The calibrated tilt index lines should indicate the nose-UP or nose-DOWN angle.

For a nose-UP attitude of the aircraft the tilt index line on the segment gear should be displaced above the fixed reference line.

For a nose-DOWN attitude of the aircraft the tilt index line on the segment gear should be displaced below the fixed reference line.

Step 13. Note exact position of the tilt index line with respect to the fixed reference line.

Step 14. Manually tilt antenna reflector to either extreme tilt position without forcing against mechanical stop. Release reflector and note that the tilt index line returns to the exact position as noted in step 13.

Step 15. Repeat step 14 for the opposite extreme tilt position.

Step 16. Loosen the vertical gyro and physically displace the roll axis ten degrees (simulating 10-degree right bank).

Step 17. Position the antenna to 90 degrees of azimuth (looking off right wing).

Step 18. Check that antenna corrects 10 degrees UP to compensate for the gyro error.

Step 19. Position the antenna to 180 degrees of azimuth (looking off left wing) and check that antenna corrects 10 degrees DOWN.

Step 20. Remount vertical gyro in its normal position and reposition antenna to zero degrees azimuth, and secure.

Step 21. Rotate BRILLIANCE control, on the PPI-1( ) Indicator, clockwise until a sweep trace appears on the indicator screen. The sweep trace should be vertical, indicating zero degree on the indicator dial.

NOTE

The aircraft's vertical gyro need not be operating for the following checks.

Step 22. Remove the material used to secure the antenna reflector assembly in the zero-degree azimuth position.

Step 23. Manually rotate antenna reflector assembly, clockwise, in 90-degree increments and note that the sweep trace of the indicator follows the antenna rotation, in a clockwise direction, and in 90-degree increments.

Step 24. Place OFF-STBY-ON switch S5001 in the STBY position.

Step 25. Lock both the AZ (azimuth drive motor) switch S2001 and the EL (tilt drive motor) switch S2002 in the ON position by replacing the cotter pins.

Step 26. Allow three to five minutes after step 24, then place OFF-STBY-ON switch in the ON position.

Step 27. Set BRILLIANCE control on indicator to provide a sweep trace of low intensity but distinguishable over the entire display, and check the following:

Sweep trace should extend from the apex of the overlay starting point, to or beyond the periphery of the display at all points.

Sweep trace should rotate at a rate of 15 rpm plus or minus three rpm.

Sweep trace should not be curved or intermittent.

Step 28. Set RANGE & MARKS switch, on the indicator, to the 20-mile range. Four equally spaced, five-mile range-mark circles should appear on the display. The fourth, or outer, circle should be about one-eighth inch from the top of the display.

Step 29. Set RANGE & MARKS switch to the 50-mile range. Five, equally spaced, ten-mile range-mark circles should appear on the display. The fifth, or outer, circle should be about one-eighth inch from the top of the display.

Step 30. Set RANGE & MARKS switch to the 150-mile range. Six, equally spaced, 25-mile range-mark circles should appear on the display. The sixth, or outer, circle should be about one-eighth inch from the top of the display.

Step 31. Rotate BRILLIANCE control fully clockwise. Display should increase in brilliance and range-mark circles should bloom.

Step 32. Rotate BRILLIANCE control fully counterclockwise. Display should be completely extinguished.

Step 33. Rotate DIMMER control, on the indicator, clockwise. Azimuth calibration marks on the indicator overlay should glow.

Step 34. Rotate DIMMER control counterclockwise until the azimuth calibration lines on the face of the indicator are just visible.

Step 35. Rotate BRILLIANCE control clockwise until sweep trace and range marks are just visible.

Step 36. Place OFF-STBY-ON switch, on the CON-1( ) Control, to the STBY position.

Step 37. Replace HV fuse F3001 in the RDR-1( ) Transmitter-Receiver. Wait one minute and place OFF-STBY-ON switch S5001 in the ON position.

Step 38. Place the METER CIRCUIT SELECTOR switch S3001, on the RDR-1( ) Transmitter-Receiver, to the MAG position. Meter M3001, on the front panel of the RDR-1( ) Transmitter-Receiver, should read approximately half-scale (0.45 to 0.55 ma meter indication). (Note reading.)

Step 39. Place switch S3001 to the DIR-SIG position. Meter M3001 should read approximately half-scale.

Step 40. Place switch S3001 to the REV-SIG position. Meter M3001 should read approximately half-scale, and within two-tenths of a milliampere of the reading obtained in step 39.

Step 41. Place switch S3001 to the AFC position. Meter M3001 should read approximately half-scale with pointer steady indicating afc lock-in.

NOTE

The following tests require target information and the aircraft should be positioned so that the antenna can see distant targets (five to 50 miles). If other radar installations exist in or close to test site, position aircraft to avoid interaction between radars.

Step 42. Rotate GAIN control, on the CON-1( ) Control, clockwise about 180 degrees.

Step 43. Set RANGE & MARKS switch S1001 to the 50-mile range.

Step 44. Orient the tilt position of the antenna by slowly rotating the ANT-TILT control, on the CON-1( ) Control, to select a stationary target, as seen on the indicator, for reference purposes. DO NOT select close-by ground targets. Note ANT-TILT setting.

Step 45. After a suitable target is selected, rotate the GAIN control, on the CON-1( ) Control, and note that the target displayed on the indicator shows a gain or loss in brilliance depending on the GAIN setting. Reset GAIN control to provide suitable display.

Step 46. Rotate ANT-TILT control, on the CON-1( ) Control, approximately 10 degrees in either direction from the setting noted in step 45. Reference target should be lost. Other targets may appear.

Step 47. Rotate ANT-TILT control to again indicate setting established in step 44. Original target should reappear on indicator in the same position as before.

Step 48. Place the CONTOUR-MAP switch, on the CON-1( ) Control, to the CONTOUR position. Total or partial blanking of targets on indicator will indicate operation of contour circuit in the receiver.

Step 49. Place the CONTOUR-MAP switch in the OFF (neutral center) position. Blanking should cease.

Step 50. Place the CONTOUR-MAP switch in the MAP position. Additional ground targets or clutter should appear on the indicator.

Step 51. Place the CONTOUR-MAP switch to the OFF (neutral center) position.

Step 52. Place the BEACON switch, on the CON-1D Control, in the BEACON position. All target displays should disappear from the indicator.

Step 53. Place meter circuit selector switch S3001, on the RDR-1B-1 Transmitter-Receiver, in the BCN (beacon) position. Panel meter M3001 should read approximately half-scale, with needle steady, indicating operation of beacon local-oscillator and afc lock-in.

Step 54. Place meter selector switch S3001 in the MAG position. Meter should show an increase of about 30 per cent over the reading noted in step 38.

NOTE

The tests made in steps 52, 53 and 54 will normally indicate the satisfactory operation of the BEACON feature of the equipment; however, a comprehensive test of BEACON operation requires that the aircraft be airborne and within range of at least one operating ground-sited beacon transponder.

Step 55. Place the BEACON switch to the OFF position. Targets should appear on the indicator, as in step 47.

Step 56. Turn equipment OFF by placing OFF-STBY-ON switch S5001 in the OFF position.

Step 57. Place all controls in the positions indicated in paragraph 3-4d(1).

e. FLIGHT TEST.--After a satisfactory ground test of the radar installation has been made, an airborne test of the several functions of the equipment may be made by following the operating instructions as outlined in section IV of this instruction book.

Operating instructions covering the several radar functions will be found in section IV as follows:

WEATHER MAPPING AND STORM DETECTION.

TERRAIN AVOIDANCE.

GROUND MAPPING.

BEACON OPERATION.

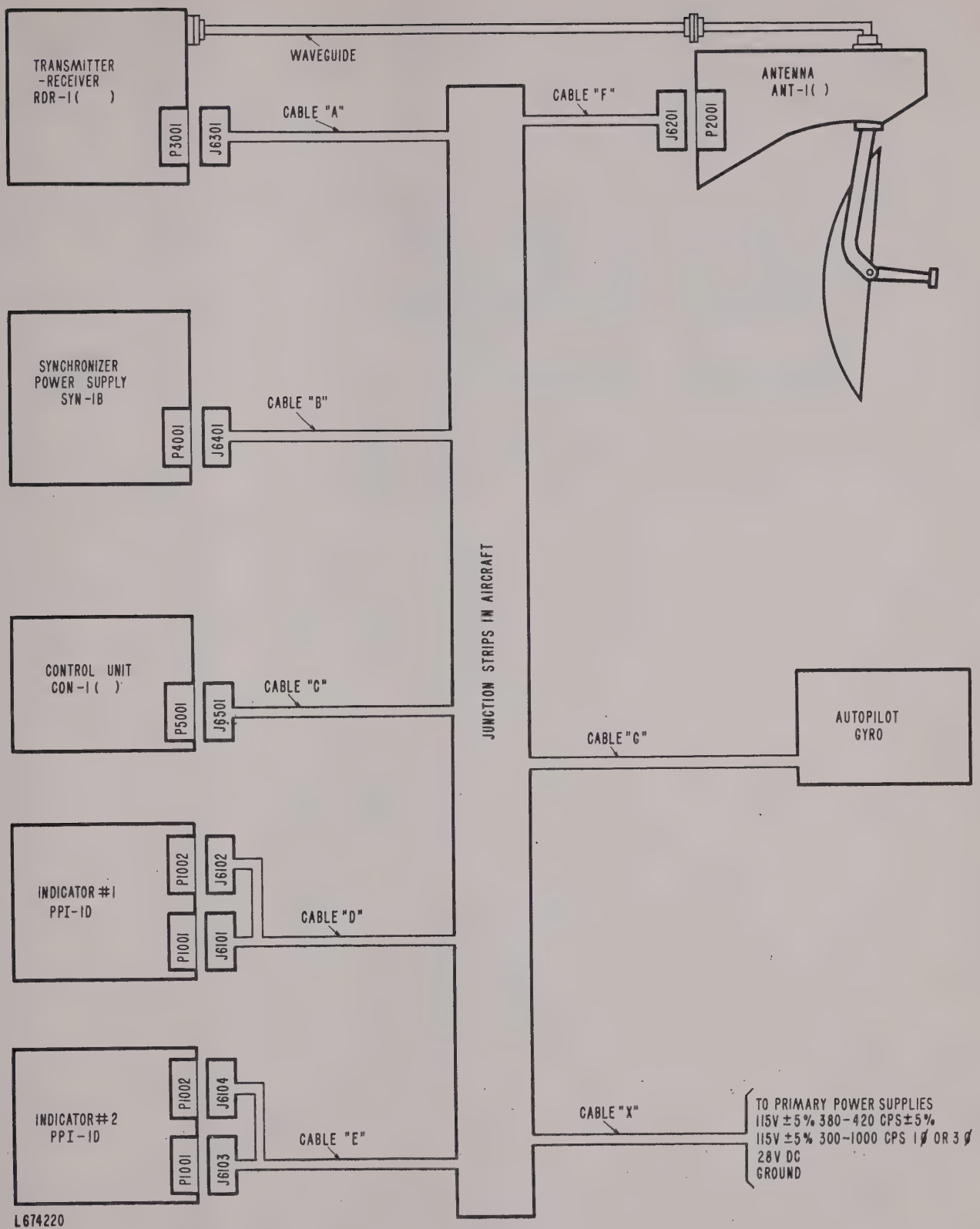


Figure 3-3. RDR-1 Airborne Radar System, Cabling Diagram

7. CONNECTIONS TO ROLL AND PITCH OUTPUT OF THE VERTICAL GYRO MUST BE MADE AS FOLLOWS:
   TO ECLIPSE-PIONEER PB10 AMPLIFIER AND SIGNAL GENERATOR PLUG J4;
   FOR RIGHT SIDE INSTALLATION OF AUTOPILOT, CONNECT TO TERMINALS AS IN "A1".
   FOR LEFT SIDE INSTALLATION OF AUTOPILOT, CONNECT TO TERMINALS AS IN "A2".
   TO SPERRY AUTOPILOT A12, CONNECT TO WIRES FROM J7 AS IN "A3" USING PROPER ISOLATION TRANSFORMER TO CHANGE VERTICAL GYRO OUTPUT TO STANDARD ARINC ROLL AND PITCH INPUT. (SPERRY ISOLATION TRANSFORMER NO.661711)
   TO GYA-1A JUNCTION BOX PLUG J101, CONNECT TO TERMINALS AS IN "A4"; USE MATING CONNECTOR AN-3106-20-15S (STRAIGHT), OR AN-3108A-20-15S (ANGLE).

8. ON TYPE PPI-1B INDICATORS THE POWER INPUT CONNECTOR P1001 AND THE VIDEO INPUT CONNECTOR P1002 ARE REMOVED FROM THE REAR OF THE INDICATOR CHASSIS AND ARE COMBINED IN ONE CONNECTOR (P1001) WHICH TERMINATES A PENDANT CABLE FROM THE INDICATOR.
   PIN 19 IS THE VIDEO INPUT TERMINAL OF P1001 ON PPI-1B INDICATORS; THE VIDEO CABLE SHIELD CONNECTS TO PIN 20.

9. UNBROKEN COAX RUNS ARE PREFERABLE. IF BREAK IS NECESSARY USE TYPE BNC CONNECTOR AT BREAK.

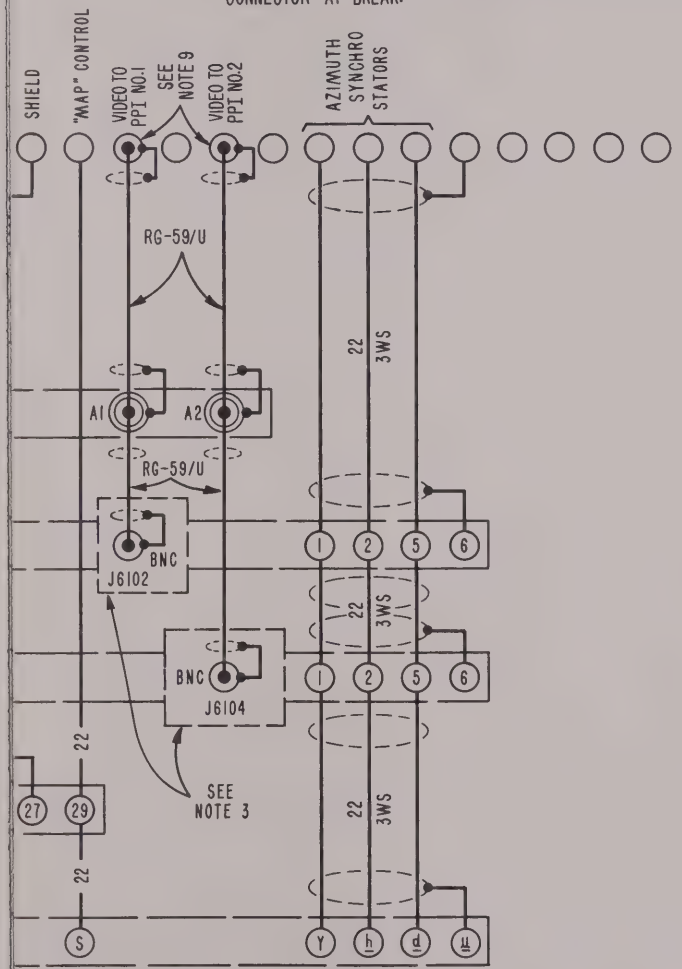
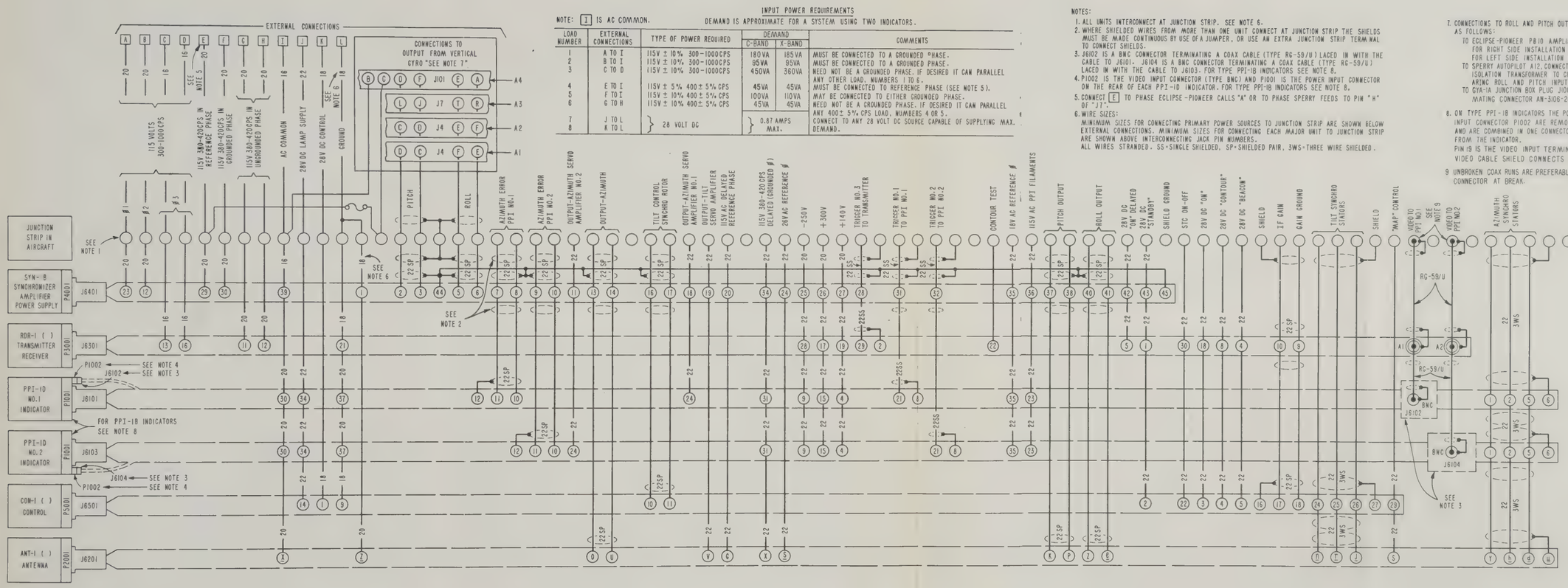


Figure 3-4. RDR-1 Airborne Radar System, System Interconnecting Wiring Diagram



INPUT POWER REQUIREMENTS

NOTE: [1] IS AC COMMON. DEMAND IS APPROXIMATE FOR A SYSTEM USING TWO INDICATORS.

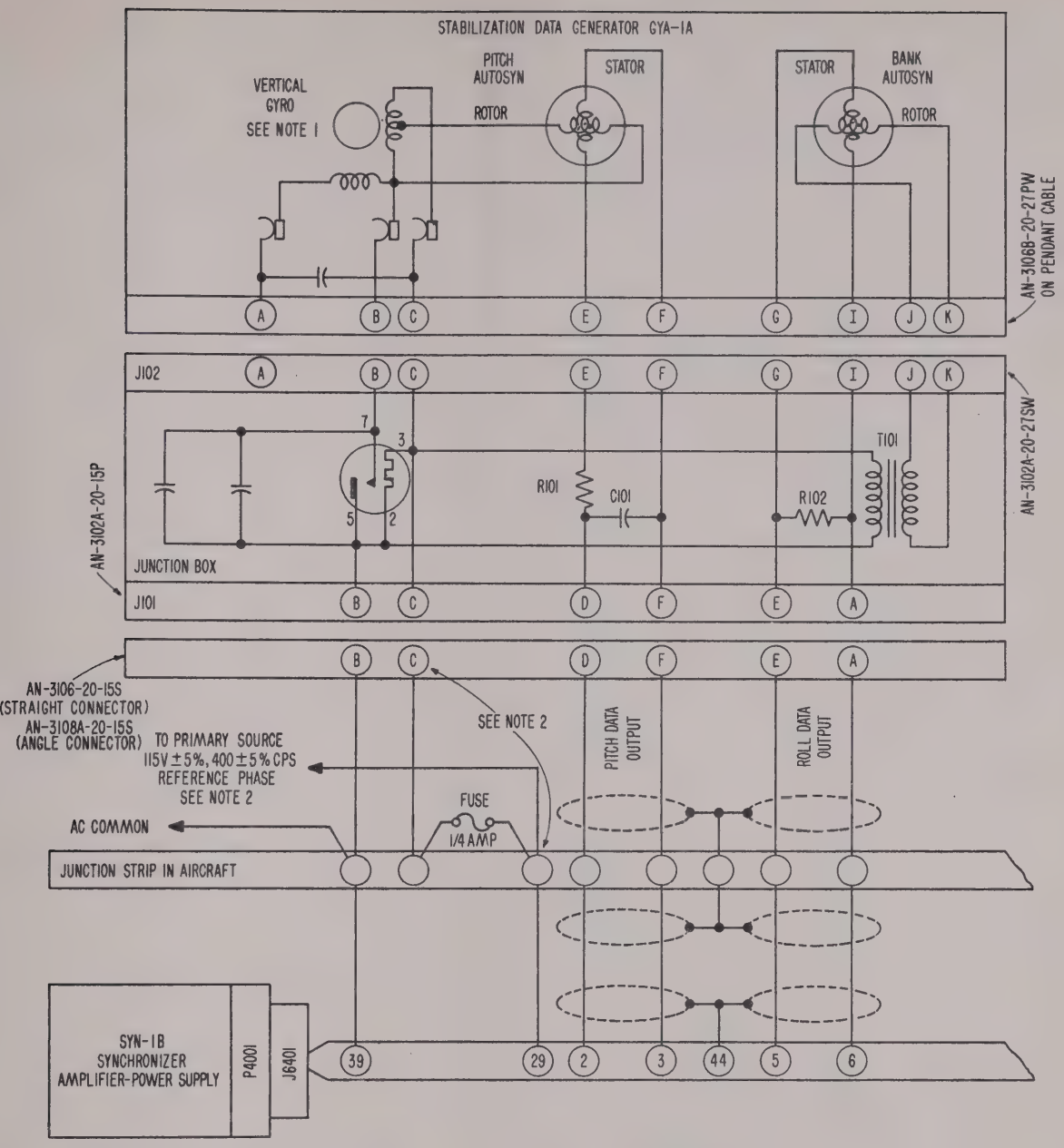
LOAD NUMBER	EXTERNAL CONNECTIONS	TYPE OF POWER REQUIRED	DEMAND C-BAND	DEMAND X-BAND	COMMENTS
1	A TO I	115V ± 10% 300-1000 CPS	180 VA	185 VA	MUST BE CONNECTED TO A GROUNDED PHASE.
2	B TO I	115V ± 10% 300-1000 CPS	95 VA	95 VA	MUST BE CONNECTED TO A GROUNDED PHASE.
3	C TO D	115V ± 10% 300-1000 CPS	450 VA	360 VA	NEED NOT BE A GROUNDED PHASE. IF DESIRED IT CAN PARALLEL ANY OTHER LOAD. NUMBERS 1 TO 6.
4	E TO I	115V ± 5% 400 ± 5% CPS	45 VA	45 VA	MUST BE CONNECTED TO REFERENCE PHASE (SEE NOTE 5).
5	F TO I	115V ± 10% 400 ± 5% CPS	100 VA	110 VA	MAY BE CONNECTED TO EITHER GROUNDED PHASE.
6	G TO H	115V ± 10% 400 ± 5% CPS	45 VA	45 VA	NEED NOT BE A GROUNDED PHASE. IF DESIRED IT CAN PARALLEL ANY 400 ± 5% CPS LOAD. NUMBERS 4 OR 5.
7	J TO L	28 VOLT DC	0.87 AMPS MAX.		CONNECT TO ANY 28 VOLT DC SOURCE CAPABLE OF SUPPLYING MAX. DEMAND.
8	K TO L	28 VOLT DC			

NOTES:

1. ALL UNITS INTERCONNECT AT JUNCTION STRIP. SEE NOTE 6.
2. WHERE SHIELDED WIRES FROM MORE THAN ONE UNIT CONNECT AT JUNCTION STRIP THE SHIELDS MUST BE MADE CONTINUOUS BY USE OF A JUMPER, OR USE AN EXTRA JUNCTION STRIP TERMINAL TO CONNECT SHIELDS.
3. J6102 IS A BNC CONNECTOR TERMINATING A COAX CABLE (TYPE RG-59/U) LACED IN WITH THE CABLE TO J6101. J6104 IS A BNC CONNECTOR TERMINATING A COAX CABLE (TYPE RG-59/U) LACED IN WITH THE CABLE TO J6103. FOR TYPE PPI-1B INDICATORS SEE NOTE 8.
4. P1002 IS THE VIDEO INPUT CONNECTOR (TYPE BNC) AND P1001 IS THE POWER INPUT CONNECTOR ON THE REAR OF EACH PPI-1D INDICATOR. FOR TYPE PPI-1B INDICATORS SEE NOTE 8.
5. CONNECT [E] TO PHASE ECLIPSE-PIONEER CALLS "A" OR TO PHASE SPERRY FEEDS TO PIN "H" OF "J1".
6. WIRE SIZES:
   MINIMUM SIZES FOR CONNECTING PRIMARY POWER SOURCES TO JUNCTION STRIP ARE SHOWN BELOW EXTERNAL CONNECTIONS. MINIMUM SIZES FOR CONNECTING EACH MAJOR UNIT TO JUNCTION STRIP ARE SHOWN ABOVE INTERCONNECTING JACK PIN NUMBERS.
   ALL WIRES STRANDED. SS=SINGLE SHIELDED, SP=SHIELDED PAIR, 3WS=THREE WIRE SHIELDED.
7. CONNECTIONS TO ROLL AND PITCH OUTPUT OF THE VERTICAL GYRO MUST BE MADE AS FOLLOWS:
   TO ECLIPSE-PIONEER P8I0 AMPLIFIER AND SIGNAL GENERATOR PLUG J4,
   FOR RIGHT SIDE INSTALLATION OF AUTOPILOT, CONNECT TO TERMINALS AS IN "A1".
   FOR LEFT SIDE INSTALLATION OF AUTOPILOT, CONNECT TO TERMINALS AS IN "A2".
   TO SPERRY AUTOPILOT A12, CONNECT TO WIRES FROM J7 AS IN "A3" USING PROPER ISOLATION TRANSFORMER TO CHANGE VERTICAL GYRO OUTPUT TO STANDARD ARINC ROLL AND PITCH INPUT. (SPERRY ISOLATION TRANSFORMER NO.6G0711)
   TO GTA-1A JUNCTION BOX PLUG J101, CONNECT TO TERMINALS AS IN "A4". USE MATING CONNECTOR AN-3106-20-15S (STRAIGHT), OR AN-3108A-20-15S (ANGLE).
8. ON TYPE PPI-1B INDICATORS THE POWER INPUT CONNECTOR P1001 AND THE VIDEO INPUT CONNECTOR P1002 ARE REMOVED FROM THE REAR OF THE INDICATOR CHASSIS AND ARE COMBINED IN ONE CONNECTOR (P1001) WHICH TERMINATES A PENDANT CABLE FROM THE INDICATOR.
   PIN 19 IS THE VIDEO INPUT TERMINAL OF P1001 ON PPI-1B INDICATORS; THE VIDEO CABLE SHIELD CONNECTS TO PIN 20.
9. UNBROKEN COAX RUNS ARE PREFERABLE. IF BREAK IS NECESSARY USE TYPE BNC CONNECTOR AT BREAK.

OR 669904

Figure 3-4. RDR-1 Airborne Radar System, System Interconnecting Wiring Diagram



NOTES:

1. THE GYA-1A STABILIZATION DATA GENERATOR REQUIRES AN OPERATING VOLTAGE OF 115V ±5%, 400 ±5% CPS.

   THE POWER REQUIRED IS; 14VA AT 88% POWER FACTOR WHILE STARTING; AND 16VA AT 92% POWER FACTOR AT FULL SPEED OF 20,000 RPM.

   THE TWO-AXIS VERTICAL GYRO WILL ERECT TO WITHIN TWO-DEGREES OF VERTICAL WITHIN FIVE MINUTES AFTER POWER IS APPLIED, AND TO WITHIN 0.6-DEGREES OF VERTICAL WITHIN SEVENTEEN MINUTES, FROM ANY POSITION OF REST.

2. THE OPERATING VOLTAGE FED TO PIN C OF J101 ON THE GYA-1A JUNCTION BOX MUST BE TAKEN FROM THE SAME PHASE AS THE SERVO SYSTEM REFERENCE VOLTAGE FED TO THE SYN-1B SYNCHRONIZER-AMPLIFIER-POWER SUPPLY THROUGH PIN 29 OF PLUG P4001.

   A ONE-QUARTER AMPERE FUSE SHOULD BE INSERTED IN SERIES WITH THE 115-VOLT SUPPLY LEAD TO PIN C OF PLUG J101 ON THE GYA-1A JUNCTION BOX.

L674616

Figure 3-5. GYA-1A Stabilization Data Generator, Simplified Schematic Showing Connections to RDR-1 Airborne Radar System

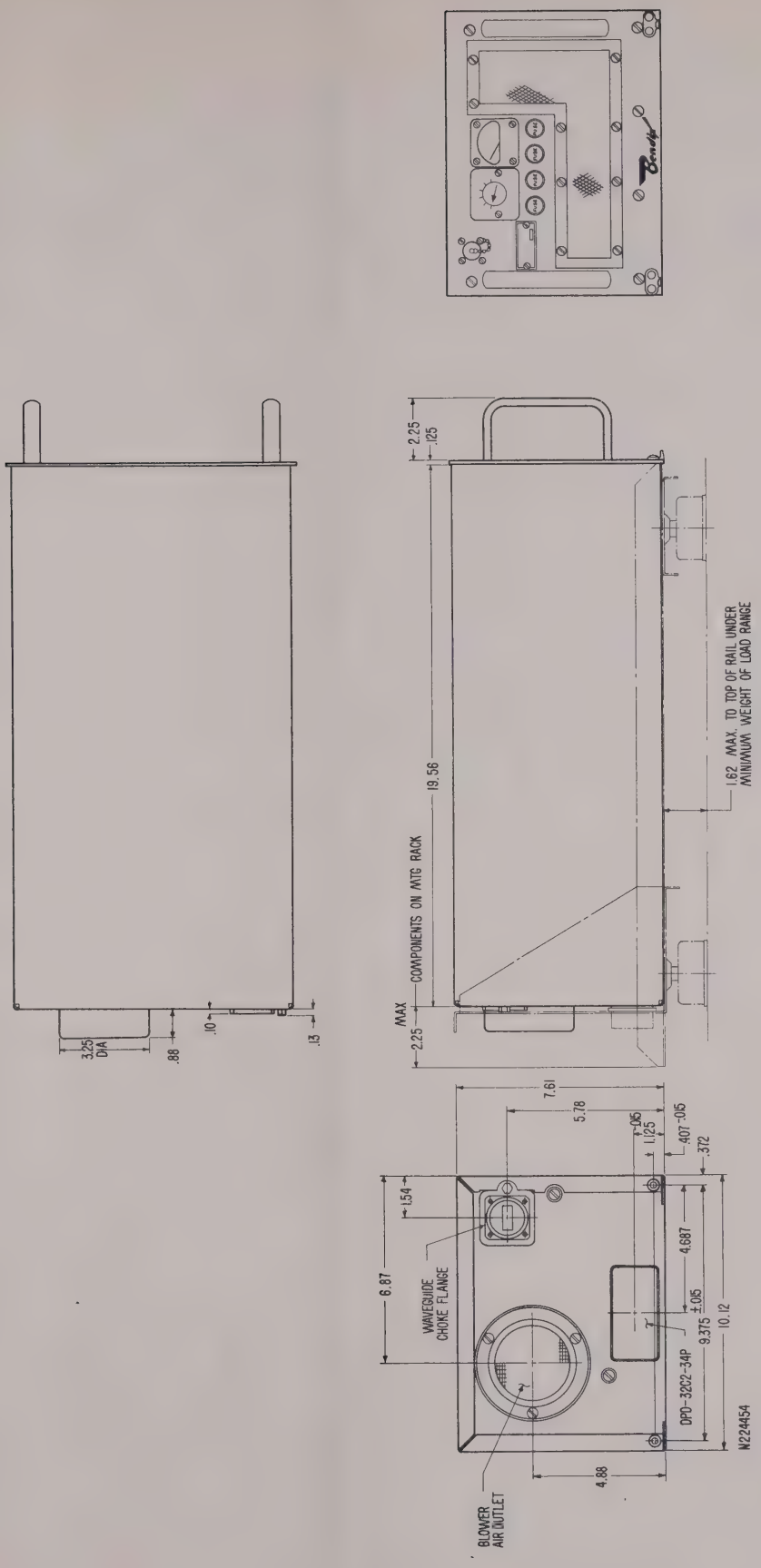


Figure 3-6. RDR-1B-1 Transmitter-Receiver, Part of RDR-1 (X-band) Airborne Radar System, Dimensional Outline Drawing

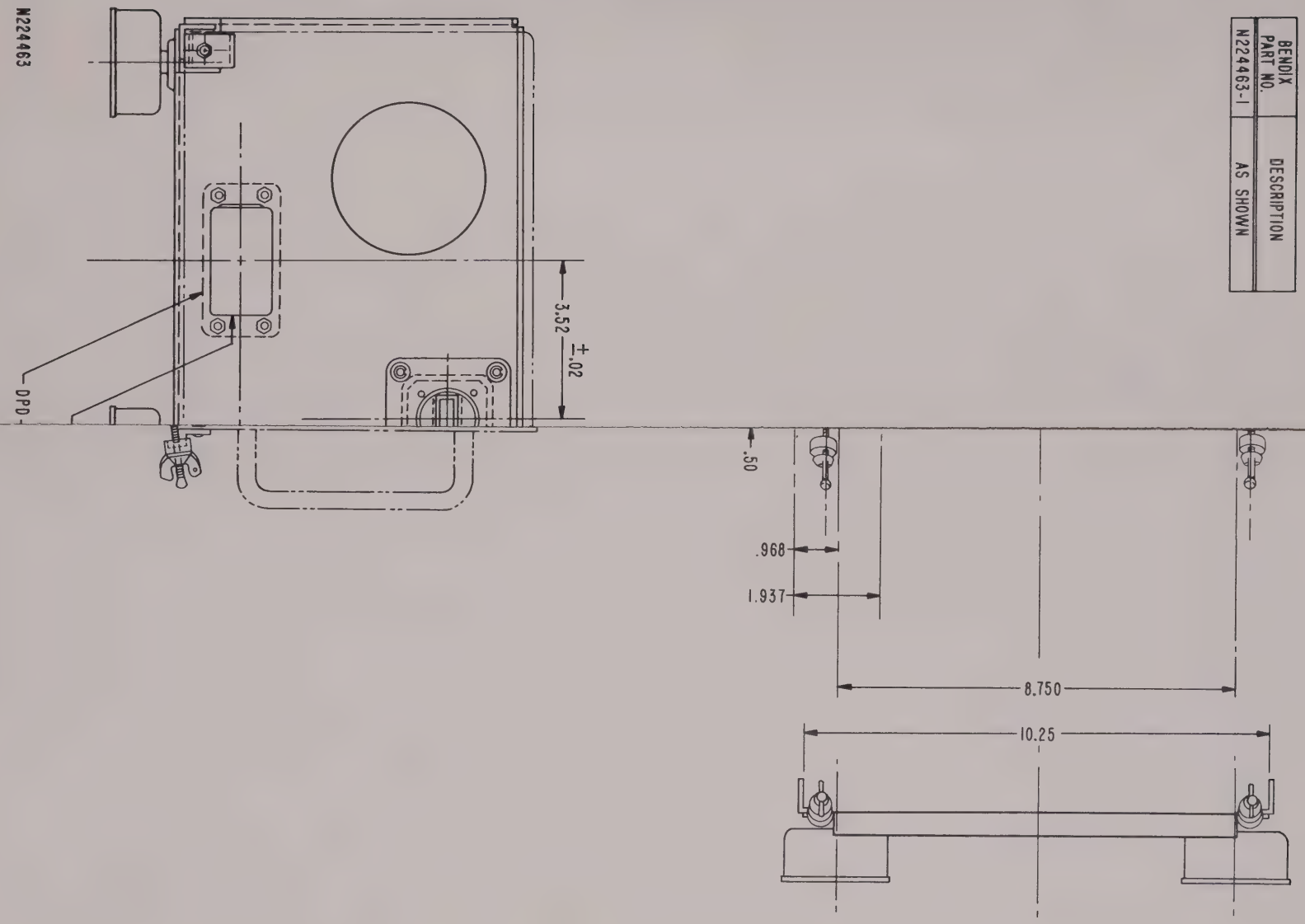


Figure 3-7. SHK-1A Shockmount, Part of RDR-1 (X-band) Airborne Radar System, Dimensional Outline Drawing

BENDIX PART NO.	DESCRIPTION
N224463-1	AS SHOWN

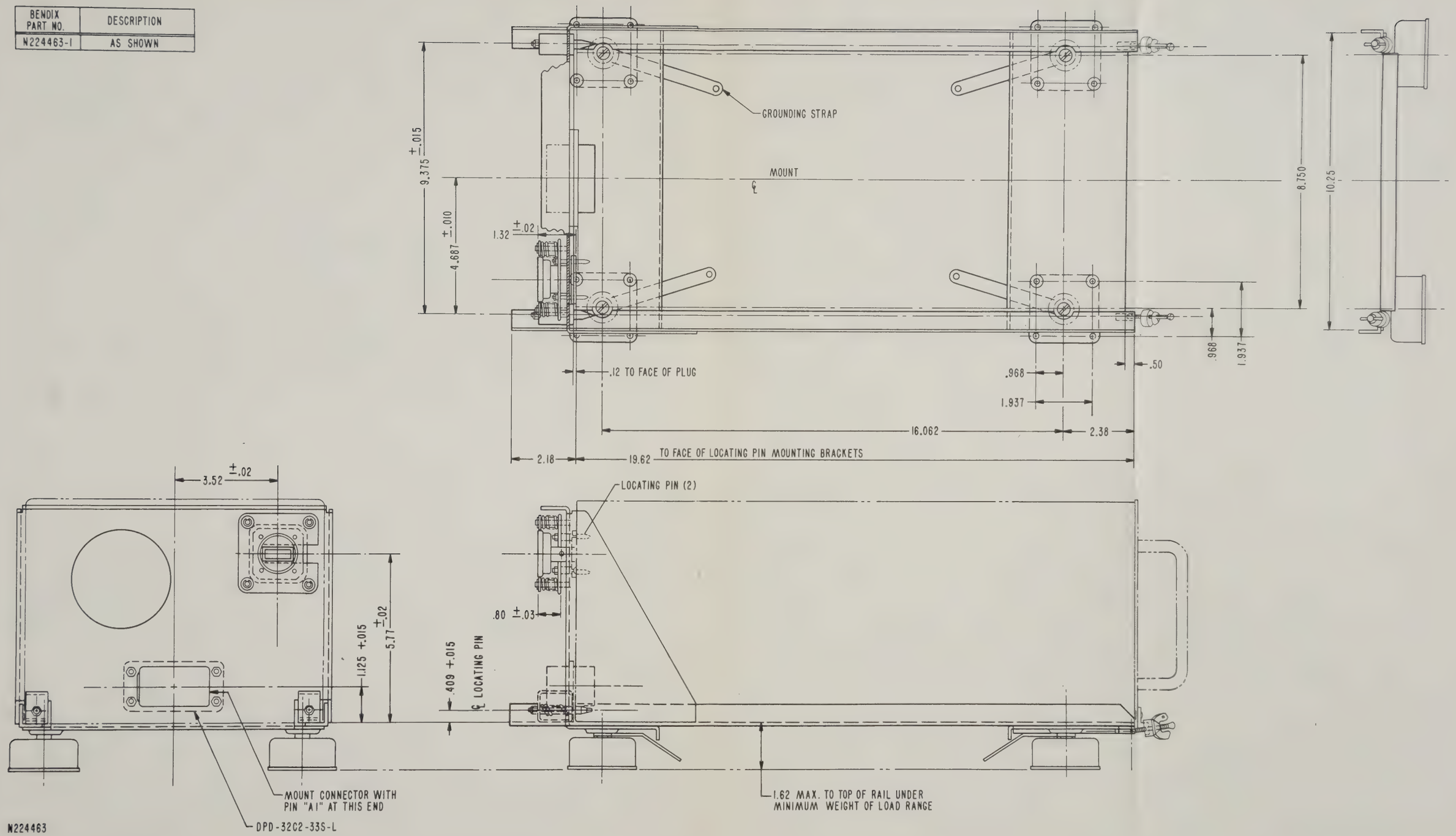


Figure 3-7. SHK-1A Shockmount, Part of RDR-1 (X-band) Airborne Radar System, Dimensional Outline Drawing

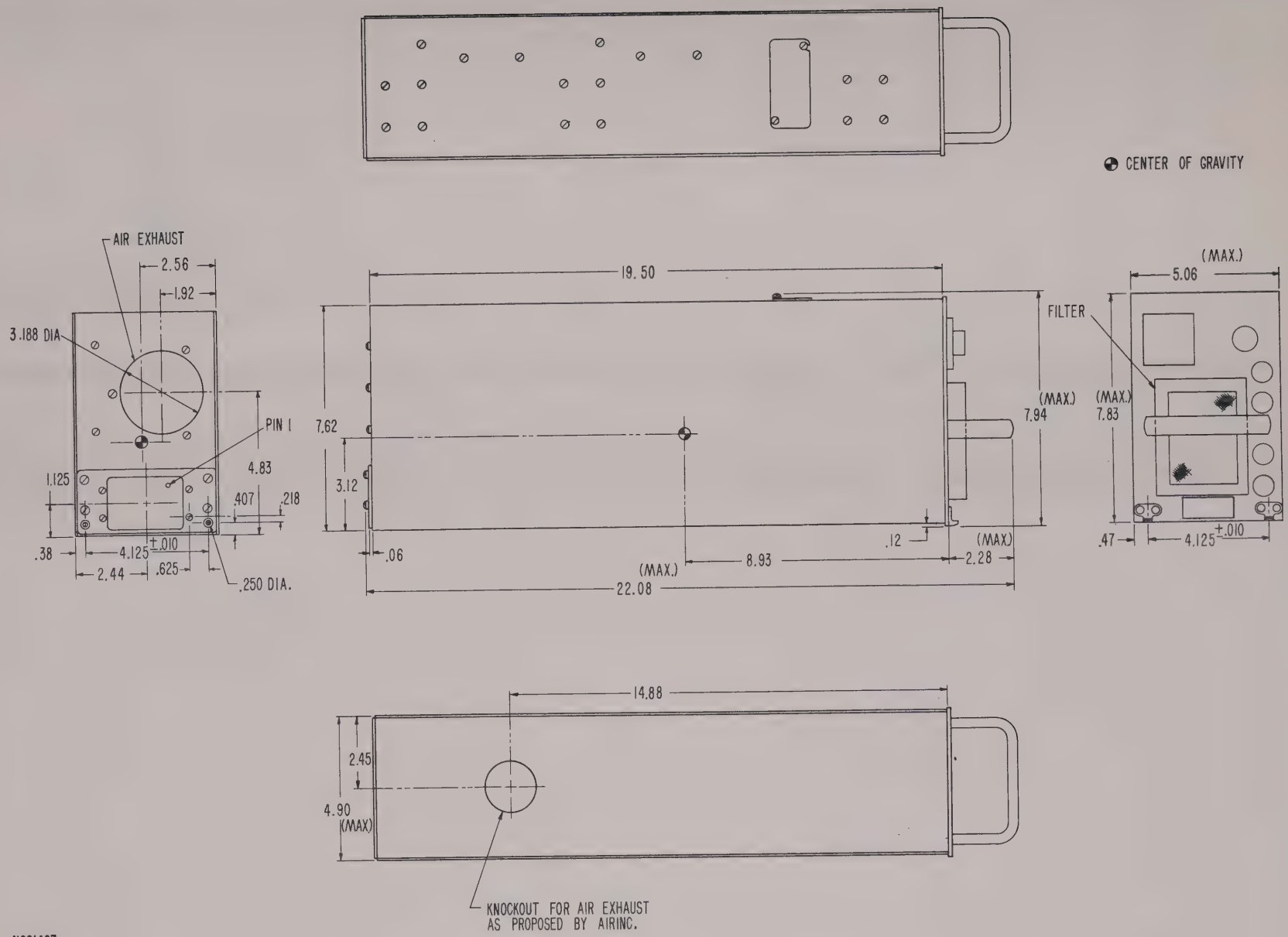


Figure 3-8. SYN-1B Synchronizer-Amplifier-Power Supply, Part of RDR-1 Airborne Radar System, Dimensional Outline Drawing

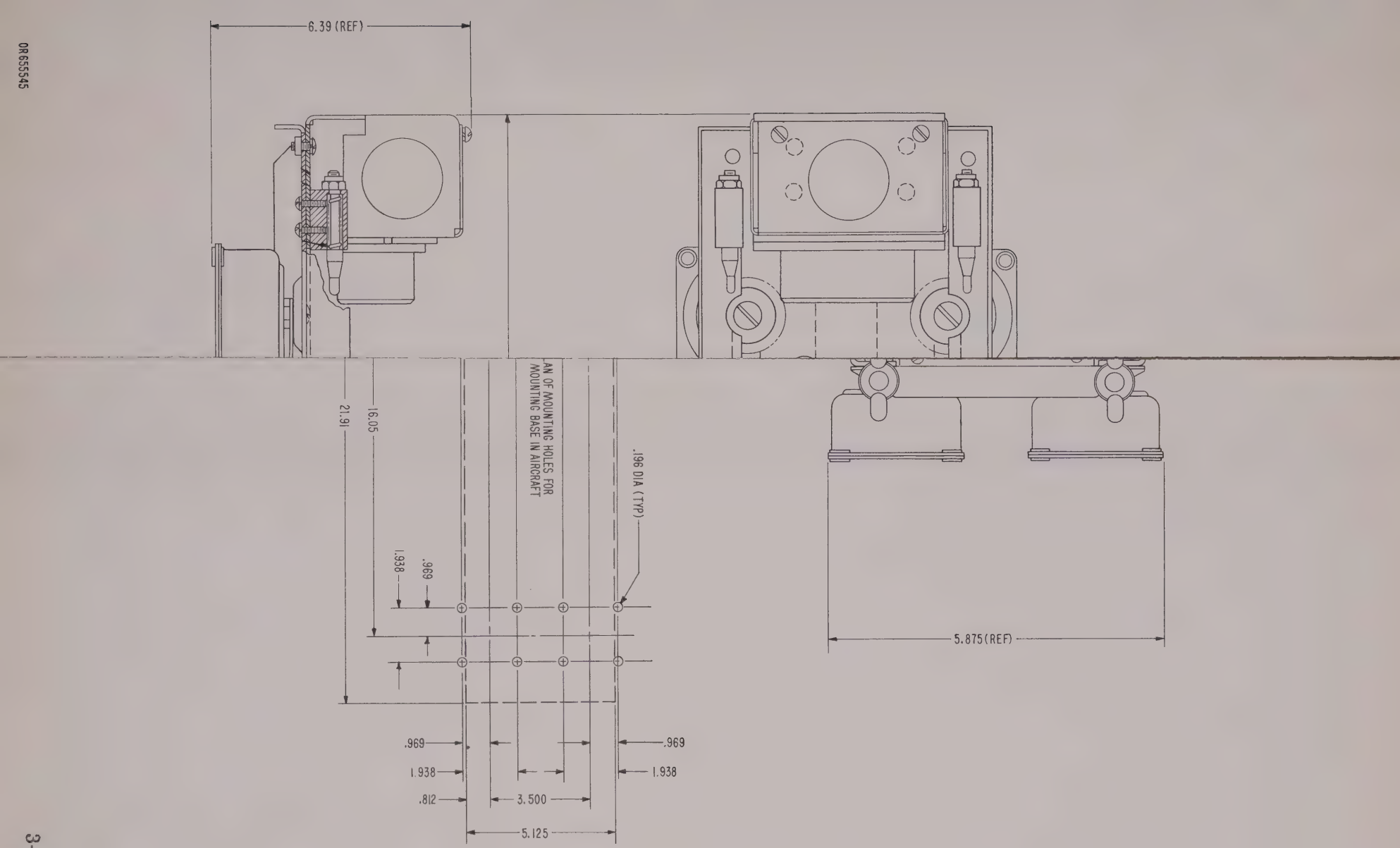


Figure 3-9. SHK-1D Shockmount, Part of RDR-1 Airborne Radar System, Dimensional Outline Drawing

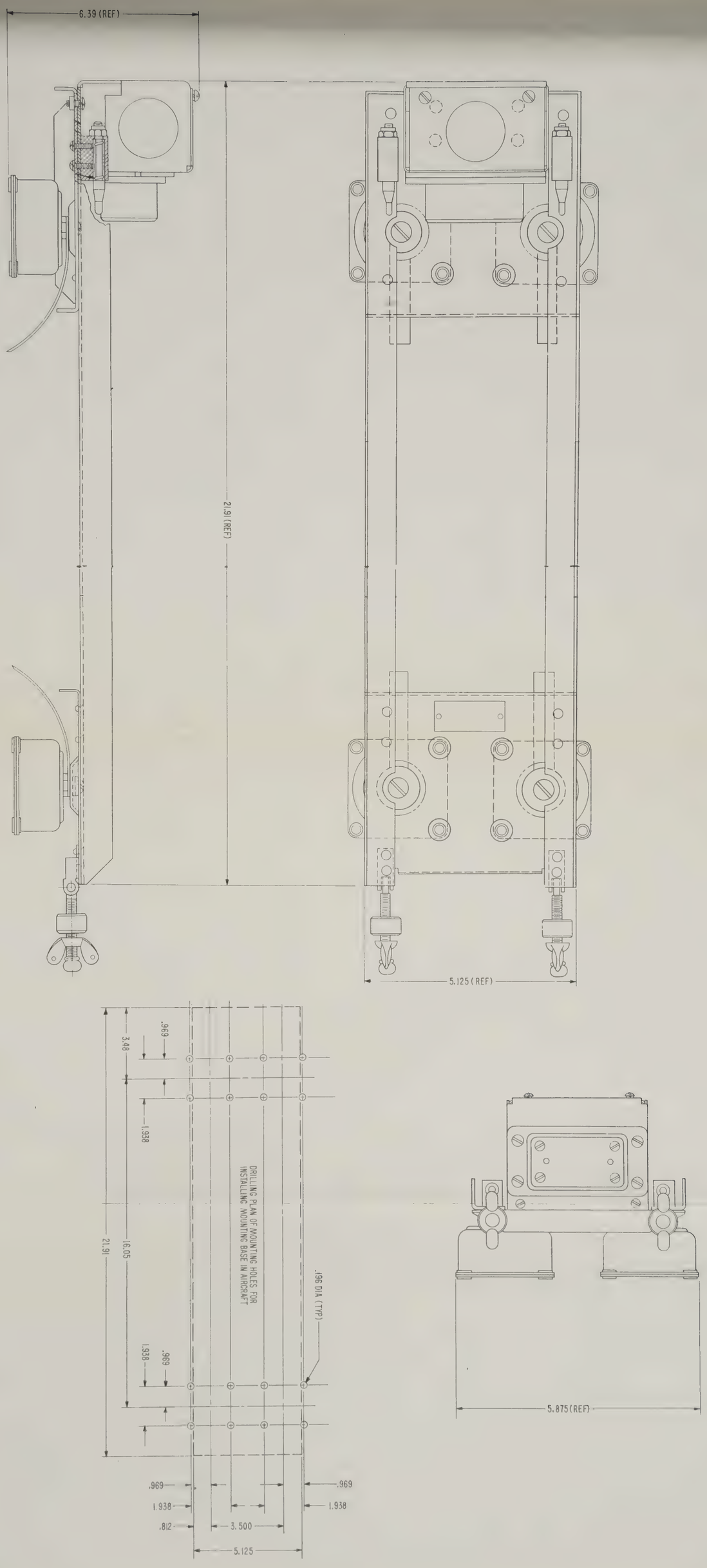


Figure 3-9. SHK-1D Shockmount, Part of RDR-1 Airborne Radar System, Dimensional Outline Drawing

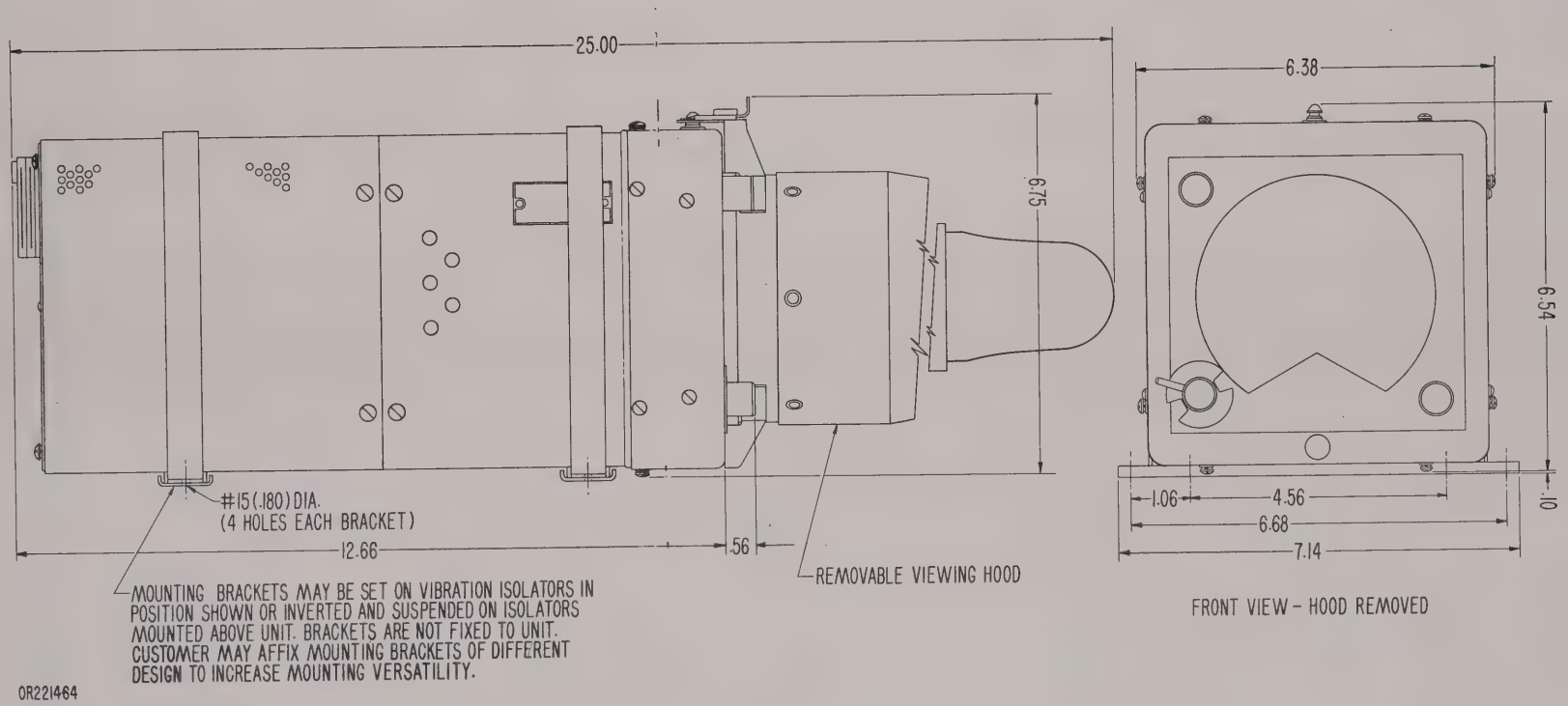


Figure 3-10. PPI-1B, 1D Indicator, Part of RDR-1 Airborne Radar System, Dimensional Outline Drawing

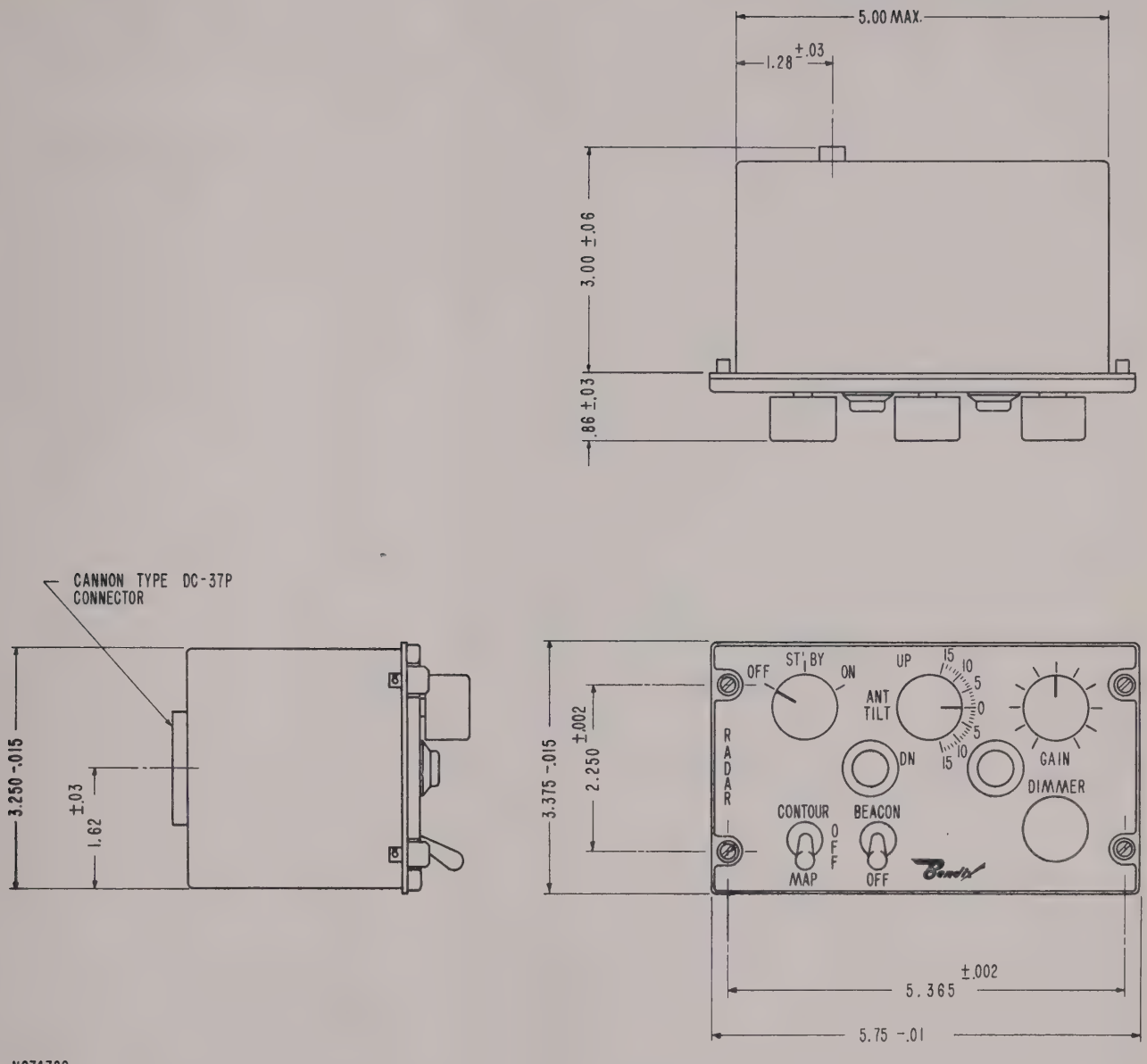
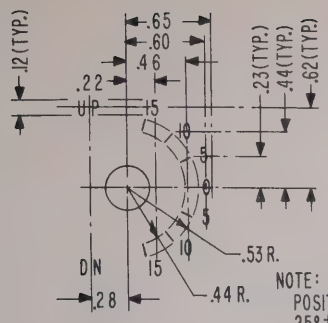


Figure 3-11. CON-1D Control, Part of RDR-1 (X-band) Airborne Radar System, Dimensional Outline Drawing



NOTE:
POSITION MARKS ARE TO BE
25° ± 1° APART
– TOL. NON-ACCUMULATIVE

1		0A17027-90	12	WASHER, SPRING	
1		HSP779R-00K	11	WASHER, FLAT	
2		C237804-3	10	BUSHING	
2		HC799P06-M	9	WASHER, LOCK SPLIT	
2		HC949B10-632	8	SCREW, PH	
1		C220908-1	7	TRANSMITTER, SYNCHRO	B5001
			6		
			5		
SEE NOTE 1	1	ERV306R2U-252	4	POTENTIOMETER	R5001
	1	N282767-1	3	MOUNTING ASSEMBLY	
	1	C282768-1	2	GEAR ASSEMBLY	
SEE NOTE 1	1	C218385-66	1	SWITCH, ROTARY	S5001

NOTES:
1. USE HARDWARE SUPPLIED WITH PART.

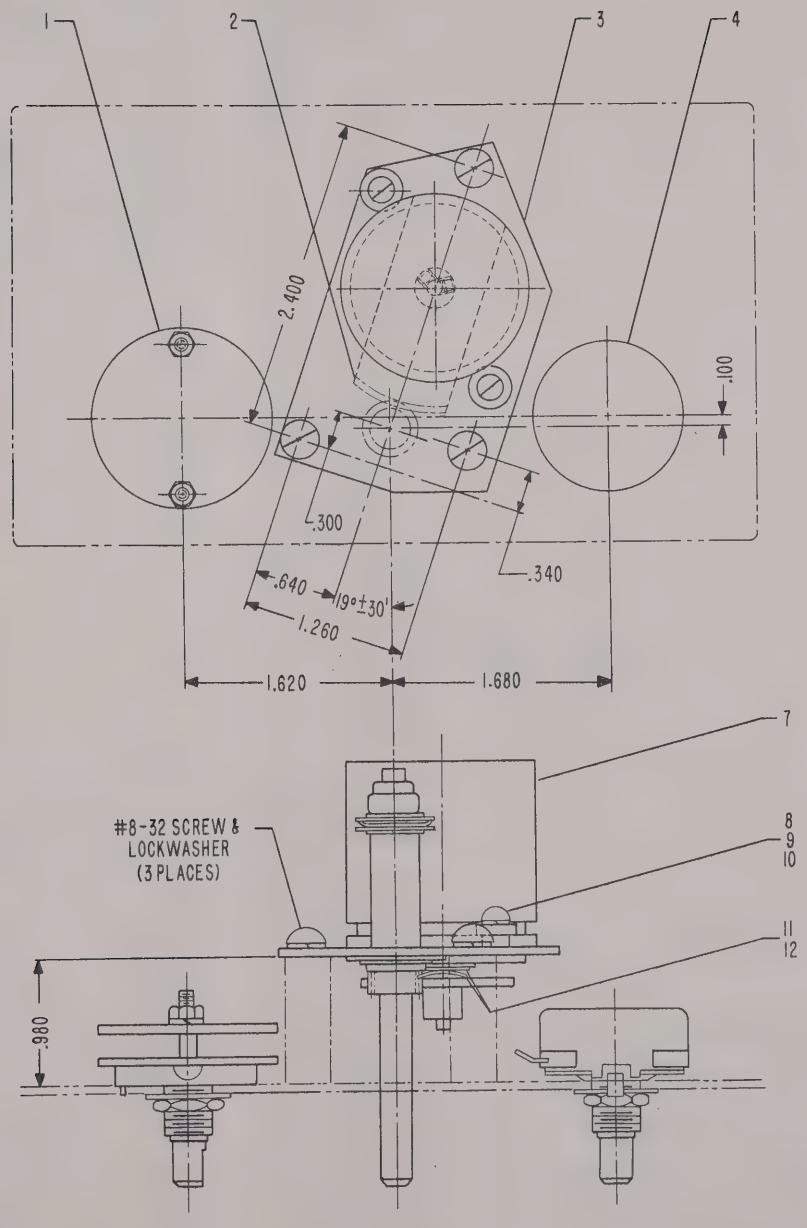
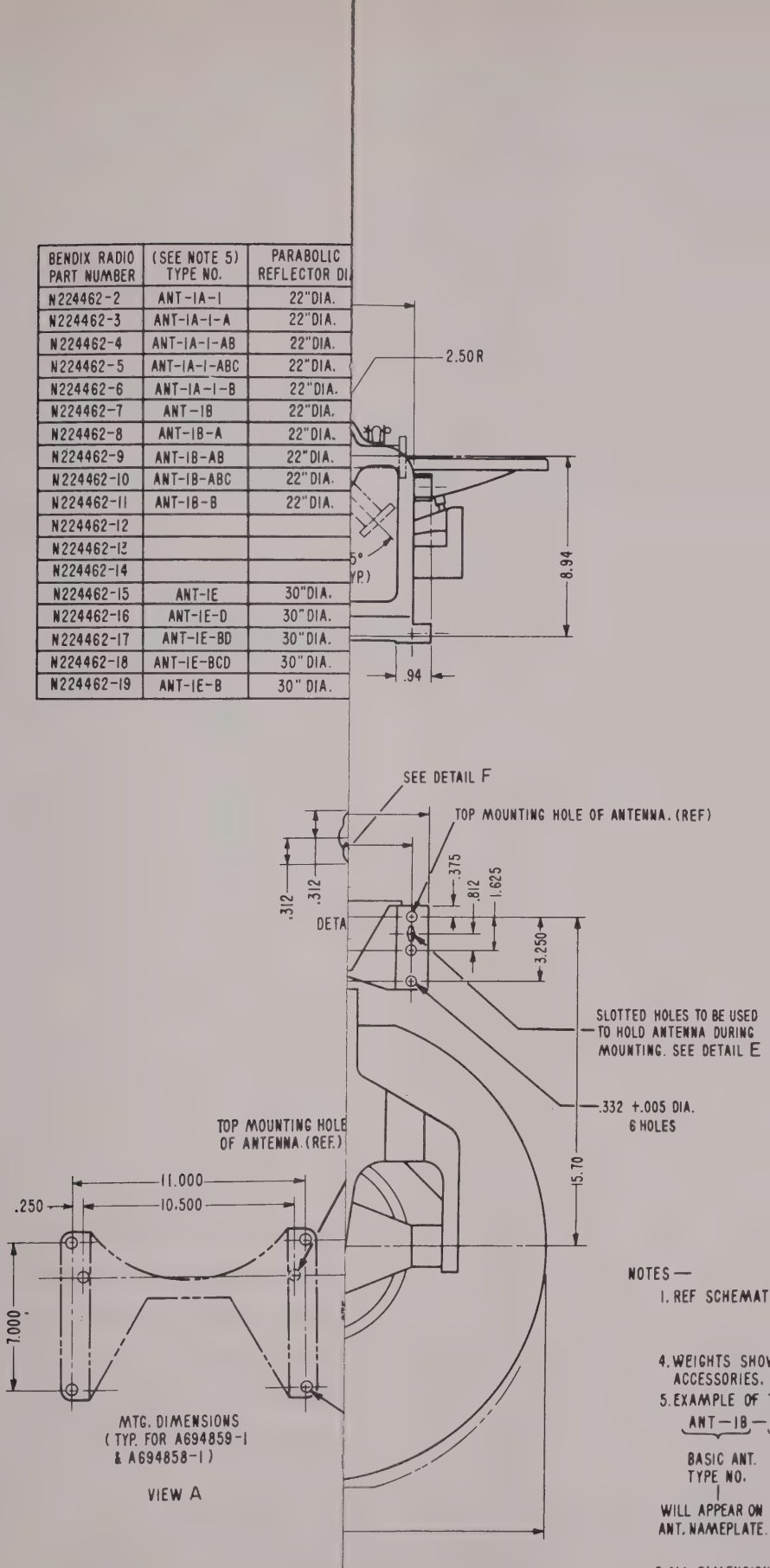


Figure 3-12. CON-1K Conversion Kit, Mounting Dimensions

BENDIX RADIO PART NUMBER	(SEE NOTE 5) TYPE NO.	PARABOLIC REFLECTOR DI
N224462-2	ANT-1A-1	22"DIA.
N224462-3	ANT-1A-1-A	22"DIA.
N224462-4	ANT-1A-1-AB	22"DIA.
N224462-5	ANT-1A-1-ABC	22"DIA.
N224462-6	ANT-1A-1-B	22"DIA.
N224462-7	ANT-1B	22"DIA.
N224462-8	ANT-1B-A	22"DIA.
N224462-9	ANT-1B-AB	22"DIA.
N224462-10	ANT-1B-ABC	22"DIA.
N224462-11	ANT-1B-B	22"DIA.
N224462-12		
N224462-13		
N224462-14		
N224462-15	ANT-1E	30"DIA.
N224462-16	ANT-1E-D	30"DIA.
N224462-17	ANT-1E-BD	30"DIA.
N224462-18	ANT-1E-BCD	30"DIA.
N224462-19	ANT-1E-B	30"DIA.



NOTES —

1. REF SCHEMATIC NO. N669558.

4. WEIGHTS SHOWN DO NOT INCLUDE ACCESSORIES.

5. EXAMPLE OF TYPE NO.

ANT—1B—ABC

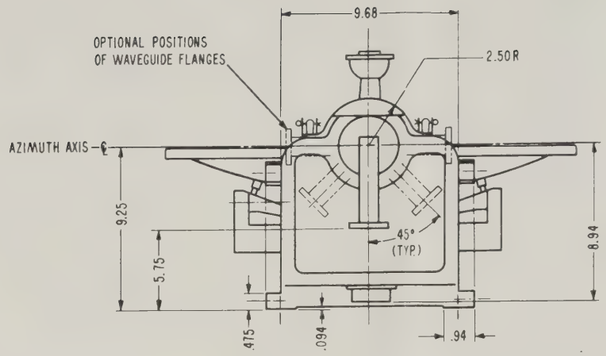
BASIC ANT. TYPE NO. — WILL APPEAR ON ANT. NAMEPLATE.

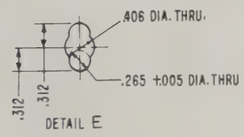
OPTIONAL ACCESSORIES IF ANY SEE COLUMNS 7,8,9 & 10 — THESE APPEAR ON IDENT. TAG. COLUMN 11.

6. ALL DIMENSIONS IN INCHES.

Figure 3-13. ANT-1B( ) Antenna, Part of RDR-1 Airborne Radar System, Dimensional Outline Drawing

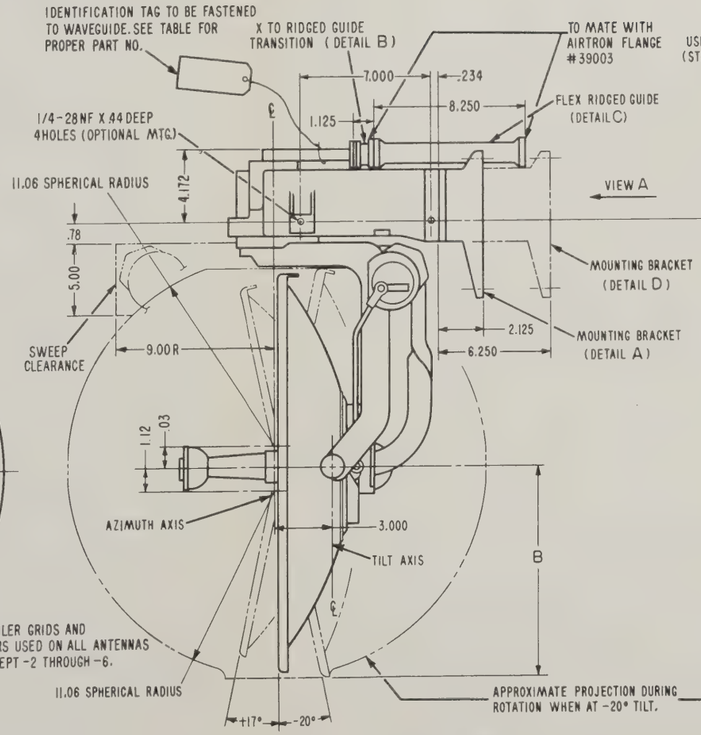
BENDIX RADIO PART NUMBER	(SEE NOTE 5) TYPE NO.	PARABOLIC REFLECTOR DIA.	DIM. A	DIM. B	NOTE 4 WEIGHT	COLUMN 7 DETAIL A MTG. BRACKET	COLUMN 8 DETAIL B TRANSITION	COLUMN 9 DETAIL C FLEXGUIDE	COLUMN 10 DETAIL D MTG. BRACKET	COLUMN 11 TAG PART NO.
N224462-2	ANT-1A-1	22"DIA.	22 1/8	11.44	23 3/4	NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	NONE
N224462-3	ANT-1A-1-A	22"DIA.	22 1/8	11.44	23 3/4	A694858-1	NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	L2080043-3
N224462-4	ANT-1A-1-AB	22"DIA.	22 1/8	11.44	23 3/4	A694858-1	A680046-1	A680047-1	NOT SUPPLIED	L2080043-4
N224462-5	ANT-1A-1-ABC	22"DIA.	22 1/8	11.44	23 3/4	A694858-1	A680046-1	NOT SUPPLIED	NOT SUPPLIED	L2080043-5
N224462-6	ANT-1A-1-B	22"DIA.	22 1/8	11.44	23 3/4	NOT SUPPLIED	A680046-1	NOT SUPPLIED	NOT SUPPLIED	L2080043-6
N224462-7	ANT-1B	22"DIA.	22 1/8	11.44		NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	NONE
N224462-8	ANT-1B-A	22"DIA.	22 1/8	11.44		A694858-1	NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	L2080043-8
N224462-9	ANT-1B-AB	22"DIA.	22 1/8	11.44		A694858-1	A680046-1	NOT SUPPLIED	NOT SUPPLIED	L2080043-9
N224462-10	ANT-1B-ABC	22"DIA.	22 1/8	11.44		A694858-1	A680046-1	A680047-1	NOT SUPPLIED	L2080043-10
N224462-11	ANT-1B-B	22"DIA.	22 1/8	11.44		NOT SUPPLIED	A680046-1	NOT SUPPLIED	NOT SUPPLIED	L2080043-11
N224462-12										
N224462-13										
N224462-14										
N224462-15	ANT-1E	30"DIA.	30	15.90		NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	NONE
N224462-16	ANT-1E-D	30"DIA.	30	15.90		NOT SUPPLIED	NOT SUPPLIED	NOT SUPPLIED	A694859-1	L2080043-16
N224462-17	ANT-1E-BD	30"DIA.	30	15.90		NOT SUPPLIED	A680046-1	NOT SUPPLIED	A694859-1	L2080043-17
N224462-18	ANT-1E-BCD	30"DIA.	30	15.90		NOT SUPPLIED	A680046-1	A680047-1	A694859-1	L2080043-18
N224462-19	ANT-1E-B	30" DIA.	30	15.90		NOT SUPPLIED	A680046-1	NOT SUPPLIED	NOT SUPPLIED	L2080043-19



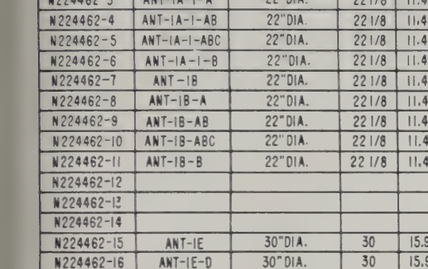


DETAIL E

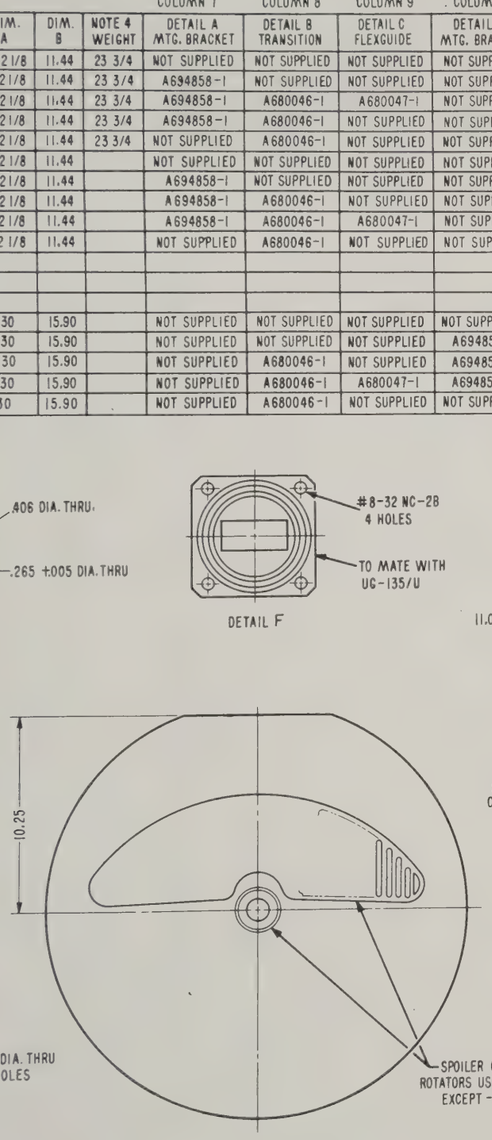
DETAIL F

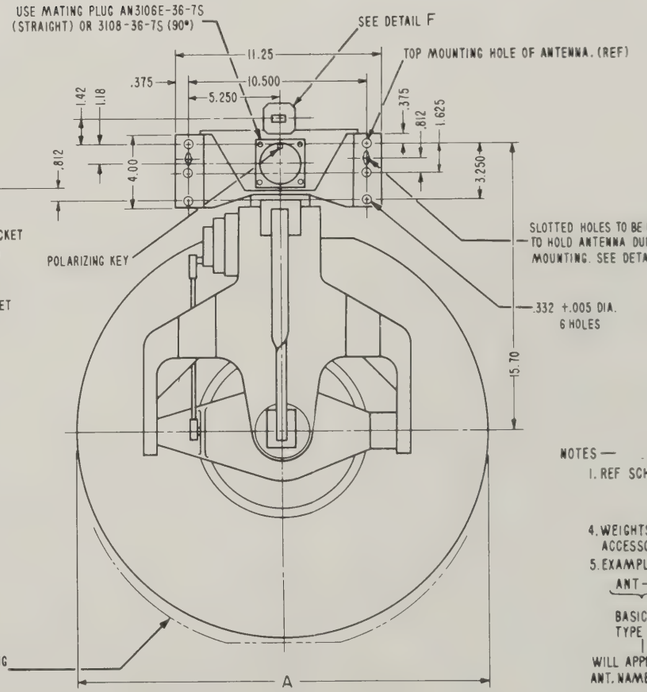


N224462-5 SHOWN



VIEW A





NOTES —

1. REF SCHEMATIC NO. N669558.
4. WEIGHTS SHOWN DO NOT INCLUDE ACCESSORIES.
5. EXAMPLE OF TYPE NO.

ANT — 1B — ABC

- ANT — 1B: BASIC ANT. TYPE NO. — WILL APPEAR ON ANT. NAMEPLATE.
- ABC: OPTIONAL ACCESSORIES IF ANY — SEE COLUMNS 7,8,9 & 10 — THESE APPEAR ON IDENT. TAG. COLUMN 11.

6. ALL DIMENSIONS IN INCHES.

N224462

Figure 3-13. ANT-1B( ) Antenna, Part of RDR-1 Airborne Radar System, Dimensional Outline Drawing

SECTION IV
OPERATION

4-1. GENERAL.

This section contains information on the operation of the RDR-1 Airborne Radar System and includes illustration material designed to assist the operator to interpret and evaluate the various radar displays resulting from normal operation.

4-2. PURPOSE OF EQUIPMENT.

The equipment is designed primarily to furnish continuous enroute weather information relative to cloud formations, rainfall rate, thunderstorms, and the areas of turbulence and icing conditions associated therewith.

By means of radar echo displays, on cathode-ray tube indicators, the system will furnish enroute weather information to enable the pilot of an aircraft to avoid the turbulence associated with thunderstorms and will act as a pathfinder to aid the pilot in selecting a path through soft spots in the weather without serious reduction in speed and with much greater safety and passenger comfort.

In addition to its primary purpose of weather mapping, the system may be used, day or night, for terrain avoidance, ground mapping and beacon operation even under adverse weather conditions.

4-3. BASIC OPERATING PRINCIPLES.

a. GENERAL.--The Bendix Type RDR-1 Airborne Radar System operates by emitting very short, intense pulses of microwave energy which are reflected by objects within the range of the set. A portion of the radiated energy, intercepted by an object having reflective characteristics, is returned along the same general path to the aircraft where it is received and converted into visible indications of range and azimuth bearing. These indications appear as luminous spots or areas on the face of the cathode-ray tube in the PPI-1( ) Indicator(s).

OPERATION

The radiated pulses of microwave energy travel at a constant rate and in straight lines. The equipment measures, with a high degree of accuracy the time required for the individual pulses of energy to travel to and return from a reflective target, then translates this data into an indication of the distance from the aircraft to the target. This information is presented visually on the PPI-1( ) Indicators. The range of the target, in nautical miles, is determined by reference to the operating range of the equipment and to the calibrated range marks appearing on the face of the cathode-ray tube in the PPI-1( ) Indicators.

The direction in which the antenna is pointed at the instant the pulse of energy is radiated, causes the indication of the echo signal to appear in a corresponding position, in azimuth, on the display. This indication shows the operator the direction, in azimuth, of the target causing the received echo signal. For practical purposes this azimuth position is shown with reference to the heading of the aircraft rather than with reference to true north as is often done on ship's radar search equipment and fixed shore installations.

The primary requirement of this equipment is the display of dangerous weather in a form which will enable the pilot to circumnavigate the most dangerous portions of thunderstorms. To accomplish this, the display of rainfall-rate contours is required. The contour circuitry incorporated with the receiver section of this equipment permits the display of rainfall gradients so the pilot can see the actual contours of differing rainfall rates surrounding the core of a thunderstorm cloud. The contour circuit, when energized, alters the normal radar presentation to display areas of high rainfall rates as black holes in the signal return. The contours of these holes in the display, representing the areas of greatest rainfall-rate gradients, are the areas of the greatest turbulence.

Figure 4-1 illustrates the maximum range of the radar (150 nautical miles), the maximum usable azimuth sweep angle (240 degrees), and the radar beam tilt limits (plus and minus 15 degrees from horizontal) which enables the pilot to observe weather above and below the plane of flight path.

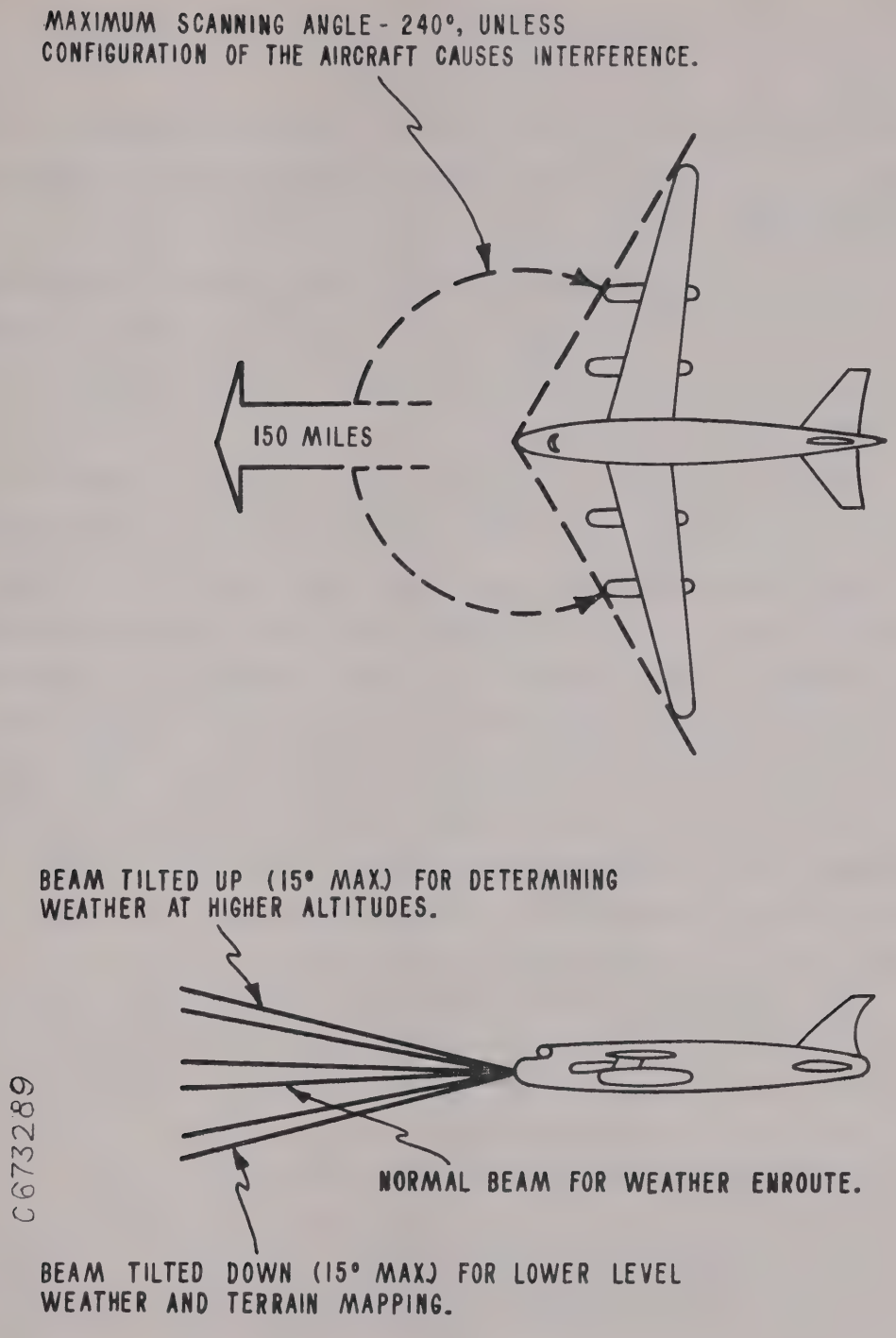

MAXIMUM SCANNING ANGLE - 240°, UNLESS
CONFIGURATION OF THE AIRCRAFT CAUSES INTERFERENCE.
150 MILES
BEAM TILTED UP (15° MAX.) FOR DETERMINING
WEATHER AT HIGHER ALTITUDES.
NORMAL BEAM FOR WEATHER ENROUTE.
BEAM TILTED DOWN (15° MAX.) FOR LOWER LEVEL
WEATHER AND TERRAIN MAPPING.
C673289

Figure 4-1. RDR-1 Airborne Radar System, Limits of Beam Coverage in Range, Elevation, and Azimuth

b. WEATHER MAPPING. --The RDR-1 Airborne Radar System provides storm detection up to a distance of approximately 150 nautical miles. This feature is equally effective day or night.

Cloud formations having less moisture content than is required to reflect a minimum discernible echo signal will not appear on the indicator display and may be traversed with normal safety. The radar will look through such clouds to detect storm conditions beyond.

A feature of the RDR-1 Airborne Radar System is the technique of PPI-scope presentation known as ISO-ECHO contours as described briefly above.

Often, when examining a rain or storm area, the entire face of the PPI indicator will show a return because of the presence of radar-reflecting particles throughout the area of the search. Although the intensity of the storm signal will vary depending on the concentration of the moisture reflecting the beam, the indicator may appear to be almost uniform in intensity across wide areas. This is due to the inability of the phosphorescent material in the cathode-ray tube to distinguish more than a limited range of light intensities. The ISO-ECHO contour circuitry employed in the RDR-1 Airborne Radar System, when in use, eliminates this difficulty. It provides an easily interpreted picture of the weather under observance. When the contour circuitry is functioning and the signal return increases above a preset level, indicating a region of high moisture content, the signal indication is erased causing a characteristic series of dark centers, surrounded by light rings, which represent storm cells. (See figure 4-2, display L.) The rainfall rate is greatest in these blacked-out centers.

The contour presentation gives immediate indication of the location of severe turbulence by indicating the gradient or rate of change of rainfall intensity with distance. The gradient is highest, and the turbulence greatest, where the lighted ring surrounding the dark center is thinnest. These are the areas of turbulence which are to be avoided.

Rainfall gradient, the rate of change of rainfall rate with distance, is a major parameter affecting the frequency and the magnitude of gusts, occurring not only in the boundaries defined by and immediately adjacent to the ISO-ECHO contours, but also within the adjacent areas as well.

The sixteen displays (A through P of figure 4-2), as seen on the PPI-1( ) Indicator, show plan views of a thunderstorm build-up covering a period of approximately two and one-half hours. This series of photographs was taken from a fixed ground position. Ground clutter, which would not normally appear in the display when the equipment is airborne, has been painted out of these photographs to display storm indications only.

In a storm area in which the ISO-ECHO contour describes a relatively small area (figure 4-2, display G, at 11:00 between 30 and 40 miles) the general turbulence can be assumed to be relatively low. Conversely, when the area described by the ISO-ECHO contour is large and leaves only a thin line of normal radar echo around it (display O between 10:00 and 11:30 at 17 to 20 miles), it can be assumed that the turbulence will be relatively severe.

The storm, shown in this series of photographs, was first detected at a distance of approximately 75 miles. The first photograph (display A) shows the storm indication at a distance of approximately 65 miles, utilizing the 150-mile range of the system.

The next two photographs (displays B and C) show the movement of the storm with time. From a point approximately 65 miles distant (in display A) at time 9:08, the storm has moved approximately 15 miles toward the fixed observation point by time 10:25 (display C), a time difference of one hour and 17 minutes.

For display D the range function of the set was changed from the 150-mile range to the 50-mile range.

Note the effect in display E with contour circuit operating as compared with display F, contour circuit OFF. The range and extent of turbulent areas is immediately apparent. The fifth photograph (display E) indicates a relatively high degree of turbulence throughout the cloud formation.

A comparison of display G, contour circuit ON, with display H, contour circuit OFF, clearly shows the storm cell content of the individual cloud formations. The four major cloud formations in display H are similar in appearance; however, when the contour circuit is operating, as in display G, it will be seen that only two of the four cloud formations contain storm cells.

Photographed seconds apart, displays I and J clearly show the difference in thunderstorm presentation, with contour circuit operating (display I) and without the benefit of contour circuitry (display J).

Utilizing the 150-mile range of the set, display K presents the entire enroute storm area.

In display L, 50-mile range, contour circuit ON, note that the two cloud formations at approximately 10:30 between 30 and 25 miles are not obscured by the intervening storm cells.

A clear view of the storm area ahead is presented in display M to a distance of 50 miles.

The contour circuit was adjusted considerably below normal for display N, yet the three storm cells are still evident.

The 20-mile range of the set was selected for display O with contour circuit ON. Note that the portion of the storm area which has invaded the 20-mile marker circle indicates considerable turbulence.

Utilizing the 150-mile range, another long-range look at the weather (display P) shows that the entire storm area now extends from range zero to approximately 65 miles.

It can be concluded tentatively that the following acceptable operational rules apply for avoiding the severest turbulence normally present within the precipitation area of thunderstorms.

Enter thunderstorm preferably where there are no ISO-ECHO contours displayed.

Enter thunderstorm where the widest contour separation is displayed.

Flight through heavy rain displayed by the radar need not be avoided. By avoiding the areas of contour "squeeze", the most turbulent portions of the heavy rain areas will also be avoided.

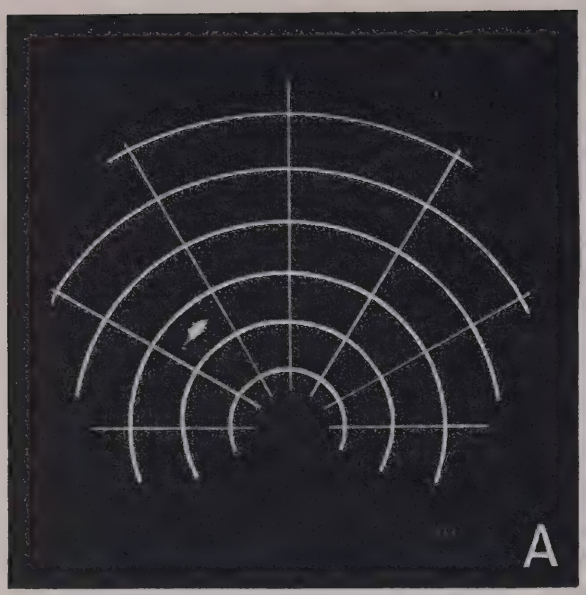
Leave the storm by route avoiding the areas of contour "squeeze" even if a turn is required.

Areas of contour "squeeze" may be recognized as those portions of the blacked-out storm centers which have only a narrow, bright edge, such as the close-in edges of the contours shown in display O, figure 4-2.

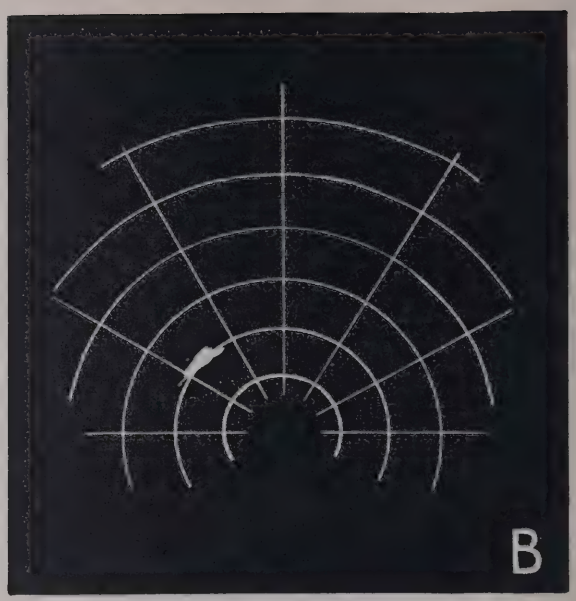
c. TERRAIN AVOIDANCE.--A method of applying a scanning radar beam to the warning and avoidance of high ground has been developed and is known as the SAFETY CIRCLE TECHNIQUE. This system is based on a 10-mile warning of high ground separated from the plane of flight path by 3200 feet or less.

The directional properties of the radar beam can be utilized for the purpose of angular measurement below a fixed, horizontal plane of reference. Such angular measurements are immediately resolved, by the radar set, into range indications.

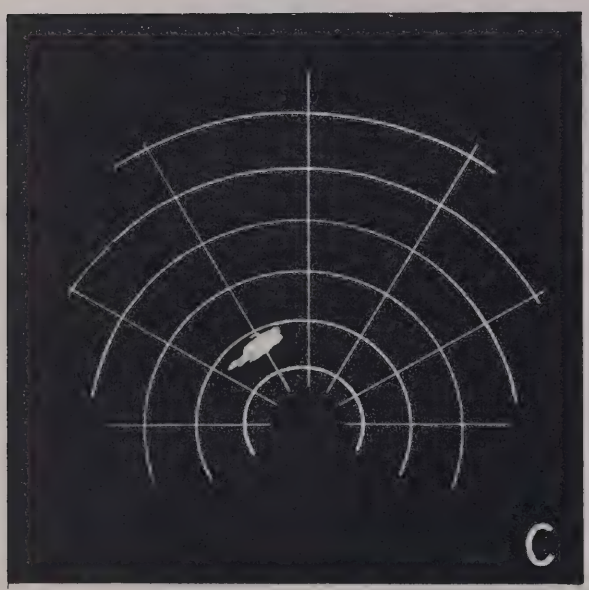
As an example: The antenna is adjusted downward at an angle such as minus one degree, and with a radar beam width of approximately four degrees, the system will observe ground return between the angles of plus 1.0 degree and minus 3.0 degrees. Utilizing the 50-mile range of the equipment, the first 10-mile range mark will define the outer boundary of a safety zone on the face of



TIME	RANGE	CONTOUR
9:08	150-MILE	ON



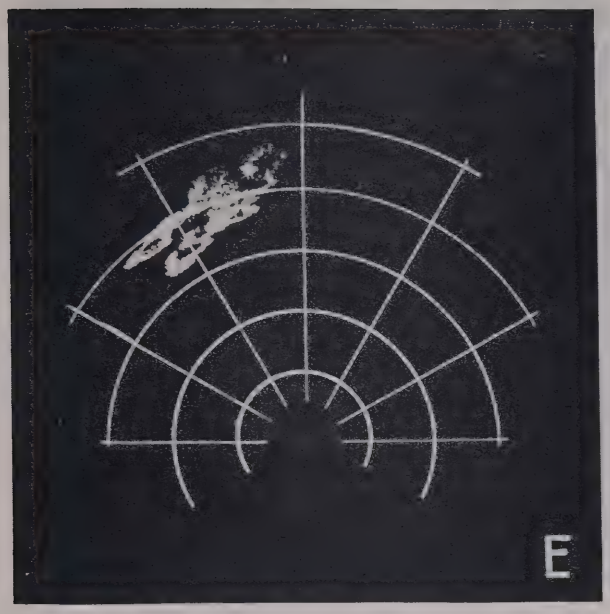
TIME	RANGE	CONTOUR
9:50	150-MILE	ON



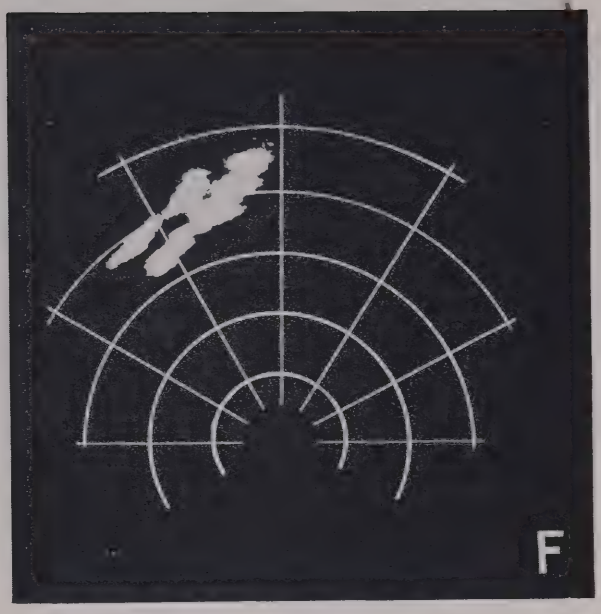
TIME	RANGE	CONTOUR
10:25	150-MILE	OFF

TIME	RANGE	CONTOUR
10:25	50-MILE	OFF

Figure 4-2. Illustrations A to D, PPI Displays of Storm (Sheet 1 of 4)



TIME	RANGE	CONTOUR
10:35	50-MILE	ON



TIME	RANGE	CONTOUR
10:35	50-MILE	OFF

TIME	RANGE	CONTOUR
10:50	50-MILE	ON

TIME	RANGE	CONTOUR
10:50	50-MILE	OFF

Figure 4-2. Illustrations E to H, PPI Displays of Storm (Sheet 2 of 4)

TIME	RANGE	CONTOUR
11:00	50-MILE	ON

TIME	RANGE	CONTOUR
11:00	50-MILE	OFF

TIME	RANGE	CONTOUR
11:10	150-MILE	ON

TIME	RANGE	CONTOUR
11:10	50-MILE	ON

Figure 4-2. Illustrations I to L, PPI Displays of Storm (Sheet 3 of 4)

TIME	RANGE	CONTOUR
11:13	50-MILE	OFF

TIME	RANGE	CONTOUR
11:15	50-MILE	ON

(Contour Turned Down)

TIME	RANGE	CONTOUR
11:20	20-MILE	ON

TIME	RANGE	CONTOUR
11:40	150-MILE	ON

Figure 4-2. Illustrations M to P, PPI Displays of Storm (Sheet 4 of 4)

the indicator. Any target invading this safety zone will be approximately 3200 feet, or less, below the aircraft's plane of flight path. With a 10-mile warning of high ground and a plan picture of the terrain presented, the pilot is alerted for whatever evasive action is indicated.

The series of illustrations presented in figure 4-3 should assist toward understanding the factors involved in the interpretation of terrain presentations under various conditions.

The SAFETY CIRCLE TECHNIQUE for terrain avoidance features a warning procedure which not only detects the presence of high ground, but also indicates the necessity for avoidance action. The operating procedure, therefore, depends primarily on the factors which govern the safe avoidance of high ground, and this definitely involves a knowledge of terrain clearance. If, for example, an aircraft is considered to be on a collision course with high ground, it is evident that the aircraft must ultimately reach a position when the avoidance action is determined by the terrain clearance which exists in the plane of the flight path and below the flight path.

The safe minimum terrain clearance in the plane of the flight path can be determined by considering the safe range of warning required for maneuvering the aircraft.

Since an alteration in course of 90 degrees or more may sometimes be necessary, then the safe minimum warning range will depend on the true air speed and rate of turn.

For an aircraft flying at a true air speed of 300 miles per hour, a rate 1 turn (180 degrees per minute) requires a turning radius of approximately 1.6 miles, and allowing for a safety margin of x3, would require a safe minimum warning range of 6.5 miles.

At 600 miles per hour the radius of a one-half rate 1 turn (90 degrees per minute) is 6.4 miles, and, allowing for the same safety margin, would require a safe warning range of about 25.6 miles.

Thus, it is evident that a safe minimum warning range can be determined for any given air speed and factor of safety.

On the other hand, the determination of a safe minimum clearance height is largely a matter of opinion. It is obvious that if a given elevation separation can always be maintained by the methods already outlined, then the risk of collision should not occur. The possibility of dangerous down drafts is ever present and the selection of a safe elevation separation should be made with this in mind.

From the above considerations, it is apparent that the operating procedure must be based on a given clearance height at a safe minimum range of warning.

WARNING

If the tilt system of the radar set is not properly aligned, the indications produced on the indicator will be false. The SAFETY CIRCLE TECHNIQUE for avoidance of high ground should not be employed unless the proper alignment and operation of the radar's tilt system has been definitely established.

d. GROUND MAPPING. --Ground mapping with the RDR-1 Airborne Radar System provides a plan picture of prominent landmarks and terrain features such as cities, shore lines, mountains, islands, bridges, etc. These terrain features are presented on the indicator in range, and in azimuth bearing with respect to the heading of the aircraft.

Of prime importance is the extension of the range of vision of the pilot to about 50 miles and the ability to see this terrain map even during darkness and overcast when normal vision is dangerously restricted.

The display resulting from ground mapping resembles an ordinary pilotage chart and is easily interpreted. Cities, open ground, and bodies of water are distinguished by the intensity of the signals they reflect back to the signal source. Cities usually provide the most intense reflections, with open ground and water providing progressively less intense reflections. It should be noted that calm bodies of water reflect very little signal back to the signal source while very rough water will provide a return signal of considerable strength.

During ground mapping operations it is desirable to view terrain between a maximum range of approximately 50 miles and the shortest possible range. It is also desirable that similar targets at different ranges be presented on the indicator display with relatively equal intensity. Both of these features are accomplished by using a radiated beam modified to provide cosecant-squared characteristics in the vertical plane. Such a beam will scan terrain between a minimum range of approximately five miles and 50 miles, from an elevation of 20,000 feet, and will provide relatively equal illumination over the scanned area. (See diagram "B", figure 4-6.)

The antenna radiates such a beam when the ground mapping function of the system is utilized (CONTOUR-MAP switch S5002 in MAP position).

Diagram "A", figure 4-6, shows the limits of ground range illuminated by a symmetrical pencil beam, from an altitude of 20,000 feet, for antenna tilt angles of minus 15 degrees and minus 5.7 degrees.

Diagram "B", figure 4-6, shows the range of ground illuminated by a (vertical plane) cosecant-squared beam, from an altitude of 20,000 feet, with antenna adjusted to optimum tilt angle.

The range and area of ground which will be scanned by the radar beam is determined by the radar beam width, the elevation of the aircraft, and the tilt angle of the antenna.

The slant range of the inner and outer boundaries of the sector scanned can be determined directly by the position of the indicator display with respect to the range mark circles. The slant range and azimuth bearing of any ground object appearing within the display can be determined by its position relative to the range-mark and azimuth calibration closest to it. (See figure 4-3.)

e. BEACON OPERATION. --During BEACON operation, the RDR-1 Airborne Radar System offers the many navigational aids provided by the extensive system of ground-sited "X"-band radar beacons.

A radar beacon is a device that is normally quiescent. Without external stimulation it does nothing. When a suitable pulsed signal reaches it, however, the beacon is actuated (triggered) by the signal and emits a pulse or series of pulses in reply.

During BEACON operation of the RDR-1 Airborne Radar System the train of pulses transmitted by the airborne radar interrogate "X"-band ground-sited radar beacons within the line-of-sight ground coverage of the transmitted beam. The transmitted pulses automatically trigger the ground-sited beacon transmitter which then sends out coded group signals on a different frequency. The coded BEACON signals, not the echo signals, are accepted by the receiving circuits of the airborne radar set and displayed on the indicator screen. Echo signals are not displayed since BEACON reception is on a frequency different from the transmitting frequency of the radar set.

The received BEACON signals are displayed on the indicator in conventional-spaced code groups which identify the individual BEACON transmitter. The display of BEACON signals, as shown in figure 4-3, n, illustrates the form in which BEACON information is presented.

The position of any code group appearing on the indicator screen will:-

Identify the ground-sited BEACON transmitter, from which it originated, by the number and grouping of the reply pulses.

Indicate the range of the BEACON transmitter by the position of the code line closest to the starting point of the sweep trace.

Indicate the azimuth bearing of the BEACON transmitter with respect to the heading of the aircraft.

Provide an immediate and continuous fix within line of sight, since range, bearing, and identity can be read directly from the radar indicator.

Provide a HOMING target. (Homing on a ground-sited BEACON may be accomplished by heading the aircraft so that the coded signal display is centered directly on the indicator's zero-degree reference line.)

In BEACON operation one-way transmission is involved in the radar interrogation and in the BEACON reply, therefore, attenuation by atmospheric conditions is of little concern. For line-of-sight contacts, BEACON operation is effective to the range limits of the radar set.

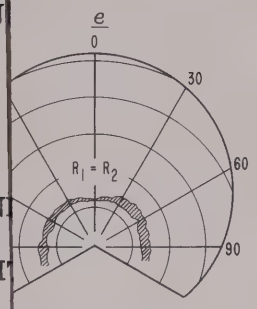
4-4. GENERAL OPERATION.

a. GENERAL. --At this point it is assumed that the radar installation has been checked and is in operating condition. All functional and operating controls are available to the operator on the CON-1( ) Control (figure 4-4) and on the PPI-1( ) Indicator (figure 4-5).

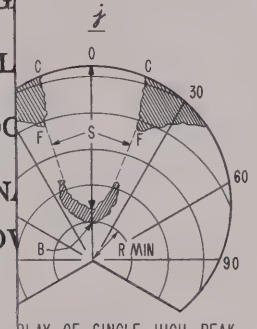
Table 4-1 lists the functions of all controls normally used by the operator.

LEGEN

REFERENCE SYMBOL	
∅1	TILT ANGLE OF ANTEN
∅2	ANGLE OF LOWER LIMI
AB,AC	VERTICAL CROSS SECTI
AE	HORIZONTAL REFEREN
AK	PLANE OF FLIGHT PAT
B	FIRST POINT OF HIGH G
BC	DEPTH OF TERRAIN ILL
BG	PORTION OF FIRST RID
FC	GROUND AREA ILLUMIN OR BEAM SEARCHING O
G	APEX OF FIRST RIDGE.
H	ALTITUDE OF AIRCRAF
h_1	ELEVATION SEPARATIO
h_{min}	MINIMUM SAFE ELEVAT
I	UNOBSTRUCTED PORTI BEYOND HIGH GROUND.
R_1	LOWER LIMIT OF BEAM. MEASURED ALONG AB.
R_2	UPPER LIMIT OF BEAM. MEASURED ALONG AC.
R_{min}	MINIMUM, SAFE, HIGH
S	SHADOW AREA.
X	DEPTH OF TERRAIN ILL



PI DISPLAY OF STEEP
ERRAIN LYING RADIALLY
QUIDISTANT FROM AIRCRAFT



PLAY OF SINGLE HIGH PEAK,
AREA, AND REMOTE GROUND
O EITHER SIDE OF SHADOW AREA

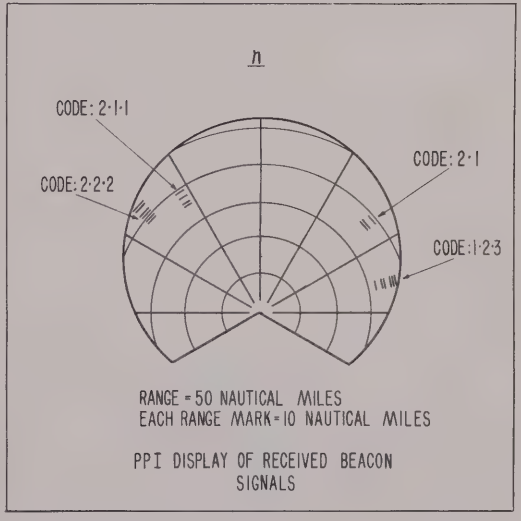


Figure 4-3. PPI Displays, Reference Diagrams

Indicate the range of the BEACON transmitter by the position of the code line closest to the starting point of the sweep trace.

Indicate the azimuth bearing of the BEACON transmitter with respect to the heading of the aircraft.

Provide an immediate and continuous fix within line of sight, since range, bearing, and identity can be read directly from the radar indicator.

Provide a HOMING target. (Homing on a ground-sited BEACON may be accomplished by heading the aircraft so that the coded signal display is centered directly on the indicator's zero-degree reference line.)

In BEACON operation one-way transmission is involved in the radar interrogation and in the BEACON reply, therefore, attenuation by atmospheric conditions is of little concern. For line-of-sight contacts, BEACON operation is effective to the range limits of the radar set.

4-4. GENERAL OPERATION.

a. GENERAL. --At this point it is assumed that the radar installation has been checked and is in operating condition. All functional and operating controls are available to the operator on the CON-1( ) Control (figure 4-4) and on the PPI-1( ) Indicator (figure 4-5).

Table 4-1 lists the functions of all controls normally used by the operator.

LEGEND FOR FIGURE 4-3

REFERENCE SYMBOL	INDICATING	SEE DIAGRAM
Ø1	TILT ANGLE OF ANTENNA.	(a, c)
Ø2	ANGLE OF LOWER LIMIT OF BEAM.	(a, c)
AB, AC	VERTICAL CROSS SECTION OF BEAM.	(a, c, f)
AE	HORIZONTAL REFERENCE PLANE.	(a, c, f, h, l, m)
AK	PLANE OF FLIGHT PATH, AIRCRAFT CLIMBING.	(m)
B	FIRST POINT OF HIGH GROUND TO INVADE SAFETY CIRCLE.	(h, i, j)
BC	DEPTH OF TERRAIN ILLUMINATED BY BEAM.	(a, c)
BG	PORTION OF FIRST RIDGE ILLUMINATED BY BEAM.	(f, g)
FC	GROUND AREA ILLUMINATED BY UNOBSTRUCTED PORTION OR BEAM SEARCHING OVER AND BEYOND HIGH GROUND.	(f, g, j)
G	APEX OF FIRST RIDGE.	(f)
H	ALTITUDE OF AIRCRAFT.	(a, c)
h_1	ELEVATION SEPARATION B TO D.	(a, c, f)
h_{min}	MINIMUM SAFE ELEVATION SEPARATION.	(f, h)
I	UNOBSTRUCTED PORTION OF BEAM SEARCHING OVER AND BEYOND HIGH GROUND.	(h)
R_1	LOWER LIMIT OF BEAM. INNER CUT OFF RANGE AS MEASURED ALONG AB.	(a, b, c, d, e)
R_2	UPPER LIMIT OF BEAM. OUTER CUT OFF RANGE AS MEASURED ALONG AC.	(a, b, c, d, e)
R_{min}	MINIMUM, SAFE, HIGH GROUND WARNING RANGE.	(f, h, i, j)
S	SHADOW AREA.	(f, g, h, i, j)
X	DEPTH OF TERRAIN ILLUMINATED BY BEAM.	(b)

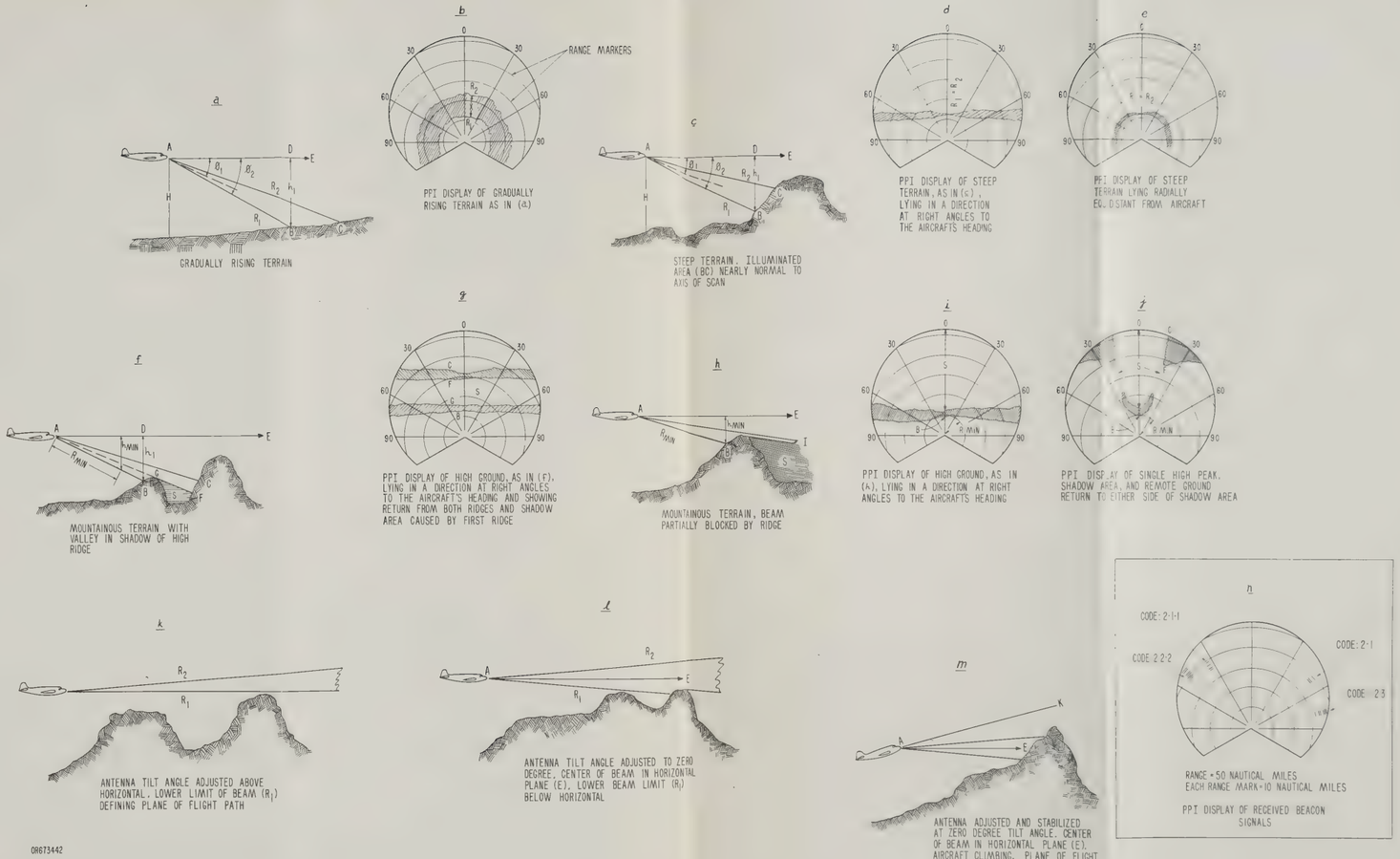

a
GRADUALLY RISING TERRAIN
b
RANGE MARKERS
PPI DISPLAY OF GRADUALLY RISING TERRAIN AS IN (a)
c
STEEP TERRAIN. ILLUMINATED AREA (BC) NEARLY NORMAL TO AXIS OF SCAN
d
PPI DISPLAY OF STEEP TERRAIN, AS IN (c), LYING IN A DIRECTION AT RIGHT ANGLES TO THE AIRCRAFTS HEADING
e
PPI DISPLAY OF STEEP TERRAIN LYING RADIALLY EQ. DISTANT FROM AIRCRAFT
f
MOUNTAINOUS TERRAIN WITH VALLEY IN SHADOW OF HIGH RIDGE
g
PPI DISPLAY OF HIGH GROUND, AS IN (f), LYING IN A DIRECTION AT RIGHT ANGLES TO THE AIRCRAFT'S HEADING AND SHOWING RETURN FROM BOTH RIDGES AND SHADOW AREA CAUSED BY FIRST RIDGE
h
MOUNTAINOUS TERRAIN, BEAM PARTIALLY BLOCKED BY RIDGE
i
PPI DISPLAY OF HIGH GROUND, AS IN (A), LYING IN A DIRECTION AT RIGHT ANGLES TO THE AIRCRAFTS HEADING
j
PPI DISPLAY OF SINGLE HIGH PEAK. SHADOW AREA, AND REMOTE GROUND RETURN TO EITHER SIDE OF SHADOW AREA
k
ANTENNA TILT ANGLE ADJUSTED ABOVE HORIZONTAL. LOWER LIMIT OF BEAM (R_1) DEFINING PLANE OF FLIGHT PATH
OR673442
l
ANTENNA TILT ANGLE ADJUSTED TO ZERO DEGREE, CENTER OF BEAM IN HORIZONTAL PLANE (E), LOWER BEAM LIMIT (R_1) BELOW HORIZONTAL
m
ANTENNA ADJUSTED AND STABILIZED AT ZERO DEGREE TILT ANGLE, CENTER OF BEAM IN HORIZONTAL PLANE (E). AIRCRAFT CLIMBING. PLANE OF FLIGHT PATH (AK)
n
CODE: 2-1-1
CODE: 2-1
CODE: 2-2-2
CODE: 2-3
RANGE = 50 NAUTICAL MILES
EACH RANGE MARK = 10 NAUTICAL MILES
PPI DISPLAY OF RECEIVED BEACON SIGNALS

Figure 4-3. PPI Displays, Reference Diagrams

TABLE 4-1. OPERATING CONTROLS

UNIT	CONTROL	SWITCH POSITION	FUNCTION
CON-( )	OFF-STBY-ON switch (S5001)	OFF	Equipment is inoperative.
		STBY	Warm-up voltages are applied. Three-minute time delay is introduced.
		ON	Equipment is fully energized after time delay.
	ANT-TILT knob		Manual control of antenna tilt. Varies radar beam radiation angle between the limits of ±15 degrees from horizontal.
	GAIN knob		Manual control of amplification of signals in i-f section of receiver.
	DIMMER knob		Manual control of panel lamp brilliance.
	BEACON ON-OFF switch (S5003)	BEACON	Energizes beacon relays to provide BEACON operation. Electrically disconnects CONTOUR-MAP switch, placing it, effectively, in OFF position.
		OFF	De-energizes beacon relays restoring set to search operations. Restores control to CONTOUR-MAP switch.
	CONTOUR-MAP switch (S5002)	OFF	Contour circuit is inoperative. Antenna radiates symmetrical pencil beam.
		CONTOUR	Contour circuit is operating. Echo returns from areas of heavy rainfall displayed as black holes within the lighter rainfall display. Antenna radiates symmetrical pencil beam.
		MAP	Contour circuit is inoperative. All target echoes displayed as bright spots or areas. Antenna radiates cosecant-squared beam for ground mapping.

TABLE 4-1. OPERATING CONTROLS (Continued)

UNIT	CONTROL	SWITCH POSITION	FUNCTION
PPI-1( )	RANGE & MARKS switch (S1001)	20-5	Provides four five-mile range marks on 20-mile sweep.
		20-10	Provides five 10-mile range marks on 50-mile sweep.
		150-25	Provides six 25-mile range marks on 150-mile sweep.
	DIMMER knob		Manual control of panel lamp brilliance.
	BRILLIANCE knob		Manual control of display brilliance.

b. STARTING THE EQUIPMENT. --Establish the following initial control settings before energizing the equipment.

CONTROLS ON CON-1( )	POSITION
OFF-STBY-ON switch	OFF
ANT-TILT knob	Zero
GAIN knob	Counterclockwise
DIMMER knob	Counterclockwise
CONTOUR-MAP switch	OFF (neutral center)
BEACON-OFF switch	OFF

CONTROLS ON PPI-1( ) INDICATOR	POSITION
DIMMER knob	Counterclockwise
RANGE & MARKS switch	Any
BRILLIANCE knob	Counterclockwise

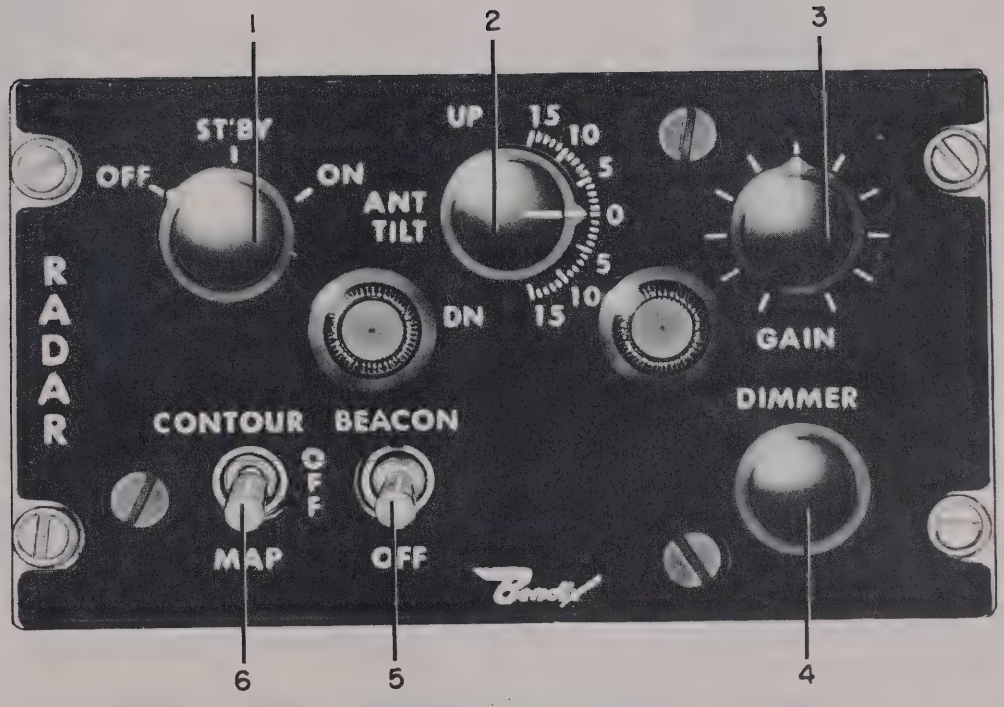


Figure 4-4. CON-1D Control, View of Front Panel and Operating Controls

1. OFF-STBY-ON switch S5001
2. ANT-TILT control knob
3. GAIN control knob, video
4. DIMMER control knob, panel lamp
5. BEACON on-off switch (S5003)
6. CONTOUR-MAP switch (S5002)

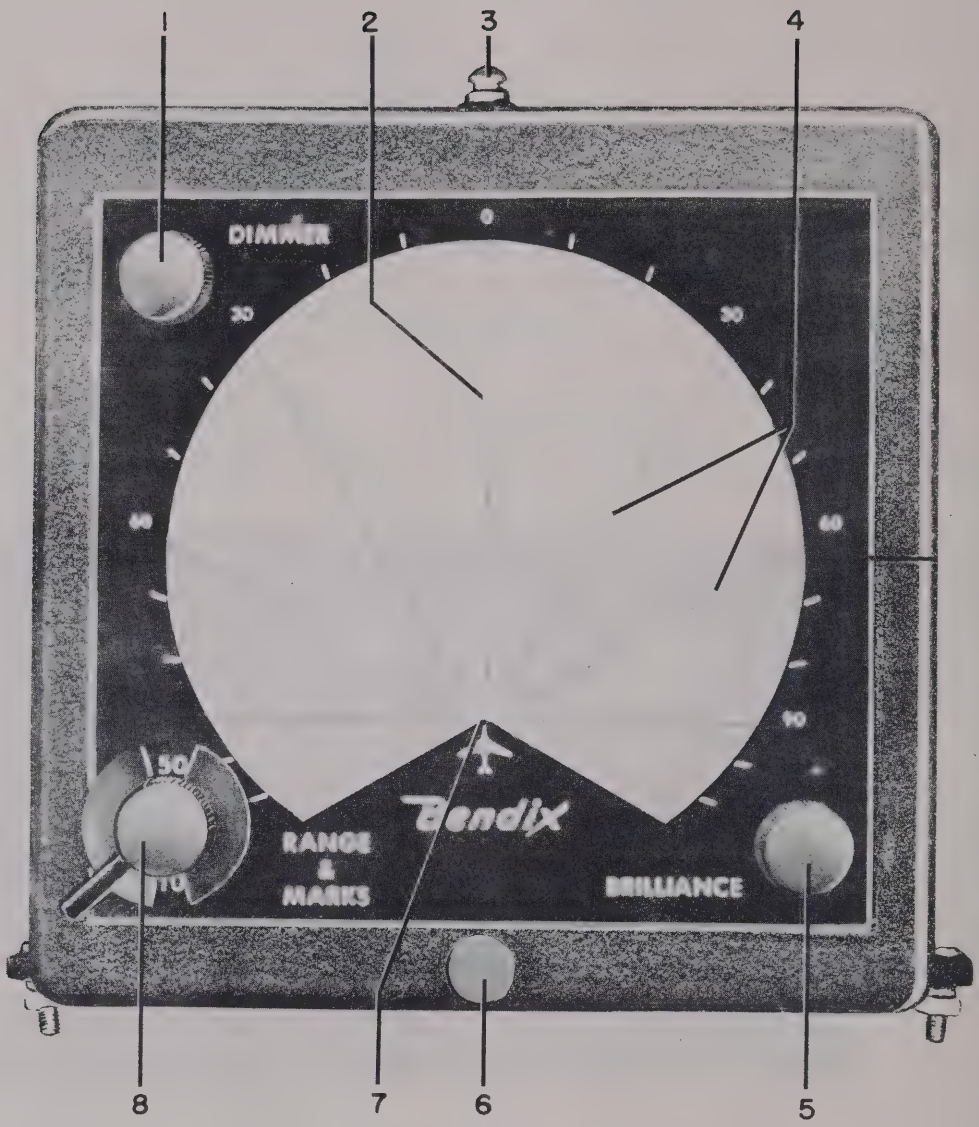


Figure 4-5. PPI-1B, 1D Indicator, View of Front Panel and Operating Controls

1. DIMMER, panel lamp, control
2. RADIAL, zero degree azimuth calibration, represents aircraft heading
3. FASTENER, hood mounting stud
4. RADIALS, azimuth calibrations, 30-degree increments
5. BRILLIANCE, indicator display, control.
6. FASTENER, hood mounting stud
7. APEX, sweep trace starting point, represents position of aircraft.
8. RANGE & MARKS, selector switch (S1001)

All primary power sources must be functioning to provide the power necessary for the operation of the radar system. The aircraft's vertical gyro must be operating. The following starting procedure is common for all functions.

Step 1. Turn the OFF-STBY-ON switch, on the CON-1( ) Control, to the STBY position.

Step 2. Wait three minutes.

NOTE

Radar operating circuits are inoperative for a three-minute time-delay period following step 1 above.

Step 3. Turn the OFF-STBY-ON switch to the ON position.

NOTE

Once the set is operating, after the three-minute time-delay period, the set may be switched from ON to STBY and back to ON, at the option of the operator, without any further time delay.

Step 4. Turn the BRILLIANCE knob, on the PPI-1( ) Indicator clockwise until sweep trace appears on the indicator screen.

Step 5. Select the desired range by rotating the RANGE & MARKS switch, on the PPI-1( ) Indicator.

NOTE

Range and range marks are selected simultaneously. Three ranges are available, each having associated range marks as follows:

RANGE IN NAUTICAL MILES	NUMBER OF RANGE MARKS	NAUTICAL MILES PER RANGE MARK
20	4	5
50	5	10
150	6	25

Step 6. Set the DIMMER control, on the CON-1( ) Control, to provide panel lighting consistent with ambient lighting conditions.

Step 7. Set the DIMMER control, on the PPI-1( ) Indicator, to provide dial lighting consistent with ambient lighting conditions.

NOTE

For proper contour indications the BRILLIANCE and GAIN controls must be set as in steps 8 and 9. For ground mapping, weather search, or beacon operations, under various ambient lighting conditions, balance the settings of the GAIN control on the CON-1( ) Control, and the BRILLIANCE control on the PPI-1( ) Indicator, to provide adequate target display with just enough range-mark brilliance for reference purposes.

Step 8. Rotate BRILLIANCE control on PPI-1( ) Indicator until sweep trace is just faintly visible under conditions of low ambient lighting.

Step 9. Rotate GAIN control on CON-1( ) Control until noise is just barely visible on the sweep trace.

c. STOPPING THE EQUIPMENT.--To stop the equipment, turn the OFF-STBY-ON switch, on the CON-1( ) Control, to the OFF position.

4-5. FUNCTIONAL OPERATING PROCEDURES.

The starting procedure outlined in paragraph 4-4 places the RDR-1 Airborne Radar System in operation and is general for all functions of the set. Subsequent use of controls is detailed under the operating procedure for each function.

a. WEATHER MAPPING AND STORM DETECTION. --The prime consideration in a WEATHER MAPPING radar is its ability to display weather information in a form which will enable the pilot of an aircraft to immediately recognize and interpret enroute weather conditions and to select a safe route through or around the most dangerous portions of thunderstorms.

To utilize this function of the radar, follow the operating procedure given below and use the information in paragraph 4-3b to interpret the resulting display of enroute weather.

Step 1. Place the RDR-1 Airborne Radar System in operation as outlined in paragraph 4-4.

Step 2. With the CONTOUR switch, on the CON-1( ) Control, in the OFF position, make a general estimate of the storm area under observation as viewed on the PPI-1( ) Indicator.

Step 3. Place the CONTOUR switch in the CONTOUR position and note the position and intensity of any storm cells (ISO-ECHO contour displays) appearing in the display.

Step 4. Repeat steps 2 and 3 for all three ranges of the system selecting for immediate use the one range which provides the best current navigating information. Ranges are selected by rotating the RANGE & MARKS switch, on the PPI-1( ) Indicator.

NOTE

The tilt angle of the antenna is normally set at zero degree. In this position, the radar beam is radiated in the horizontal plane. The width of the radar beam provides adequate vertical coverage under normal weather mapping operations; however, it is occasionally advisable or desirable to scan the weather above or below the normal beam coverage. In such cases proceed as in steps 5 and 6.

Step 5. To scan above the normal horizontal beam coverage, adjust the ANT-TILT knob, on the CON-1( ) Control, UP, in five-degree increments, allowing sufficient time between adjustments for a clear presentation to develop on the indicator.

Step 6. To scan below the normal horizontal beam coverage adjust the ANT-TILT knob, on the CON-1( ) Control, DOWN, in five-degree increments, allowing sufficient time between adjustments for a clear presentation to develop on the indicator.

Step 7. Reposition the ANT-TILT knob to zero degree for normal horizontal scan.

b. TERRAIN AVOIDANCE. --To utilize this function of the radar proceed as follows:

Step 1. Place the RDR-1 Airborne Radar System in operation as outlined in paragraph 4-4.

Step 2. Adjust the ANT-TILT control, on the CON-1( ) Control DOWN one degree.

Step 3. Select the 50-mile range of the equipment by the RANGE & MARKS selector knob on the PPI -1( ) Indicator.

NOTE

Five 10-mile range-marker circles will appear on the indicator. The first 10-mile marker will define the circle of safety. Any obstacle invading this safety circle is indicated to be in excess of the maximum height to allow the minimum safe elevation separation between the obstacle and the plane of the flight path, thus providing the pilot with a 10-mile warning of high ground indicating that evasive action should be initiated.

NOTE

While the SAFETY CIRCLE TECHNIQUE for terrain avoidance is based on simple trigonometric functions, the operator is directed to consider all of the factors outlined under paragraph 4-3c.

It should be realized, when using the radar set as a warning device for terrain avoidance, that the tolerances present in the setting of the antenna-tilt angle and in the antenna stabilization may be additive and the resulting error may be appreciable under certain conditions of use. Therefore, due allowance should be made for these possible errors by initiating evasive action at a maximum rather than a minimum range when such action is indicated.

WARNING

If the tilt system of the radar set is not properly aligned, the indications produced on the indicator will be false. The SAFETY CIRCLE TECHNIQUE for avoidance of high ground should not be employed unless the proper alignment and operation of the radar's tilt system has been definitely established.

c. GROUND MAPPING. --To utilize this function of the radar, follow the operating procedures given below and use the information in paragraph 4-3d to interpret the resulting display.

Step 1. Place the RDR-1 Airborne Radar System in operation as outlined in paragraph 4-4.

Step 2. Rotate the RANGE & MARKS control, on the PPI-1( ) Indicator to select the 50-mile range.

Step 3. Place the CONTOUR-MAP switch, on the CON-1( ) Control, in the MAP position to radiate a cosecant-squared beam for ground mapping.

Step 4. Adjust the antenna tilt angle, by rotating the ANT-TILT knob, on the CON-1( ) Control, to obtain the most uniform display of terrain over the area of interest. (See b* of diagram "B", figure 4-3.) The antenna tilt angle required will normally be around minus four degrees.

NOTE

If it is desired to selectively scan smaller areas of terrain at various ranges, or to scan terrain at ranges in excess of 50 miles, the pencil-beam feature of the equipment may be employed in conjunction with the proper setting of RANGE & MARKS selector switch. Pencil beam is radiated when CONTOUR-MAP switch is in neutral center position. It should be noted that a larger of area of terrain will be scanned for an increase in aircraft altitude or a decrease in antenna tilt. (See diagram "A", figure 4-6.)

d. BEACON OPERATION. --To utilize this function of the radar, follow the operating procedure given below and use the information in paragraph 4-3e to interpret the resulting display.

Step 1. Place the RDR-1 Airborne Radar System in operation as outlined in paragraph 4-4.

Step 2. Select the desired range of operation by rotating the RANGE & MARKS switch, on the PPI-1( ) Indicator.

Step 3. Place the BEACON-OFF switch, on the CON-1( ) Control, in BEACON position.

Step 4. Rotate ANT-TILT control, on the CON-1( ) Control, to obtain a display of the ground area of interest.

Step 5. Observe BEACON reply signals on the indicator.

Step 6. Readjust the antenna tilt angle and/or the range function to provide the most usable, current, display of BEACON reply signals.

NOTE

The distance between the aircraft and a ground-sited beacon is interpolated by noting, on the indicator, the position of the first (closest-in-range) pulse, of a reply signal, with reference to the range mark circle closest to it.

LEGEND, FIGURE 4-6.

DIAGRAM A

(Pencil-beam)

a. Altitude of aircraft (20,000 feet)

b. Antenna tilt angle (minus 15 degrees to center of pencil-beam)

c. Beam width (3.8 degrees using 22-inch reflector)

d. Range of ground illuminated (10.8 to 14.2 nautical miles, approximately)

e. Antenna tilt angle (minus 5.7 degrees)

f. Beam width (3.8 degrees using 22-inch reflector)

g. Range of ground area scanned (24.6 to 50 nautical miles, approximately)

h. Plane of flight path

i. PPI display of ground area scanned (conditions a, b, c)

j. PPI display of ground area scanned (conditions a, e, f)

DIAGRAM B

(Cosecant-squared beam)

a. Altitude of aircraft (20,000 feet)

b.* Antenna tilt angle (*must be adjusted to optimum tilt angle for most uniform display of terrain over the area of interest)

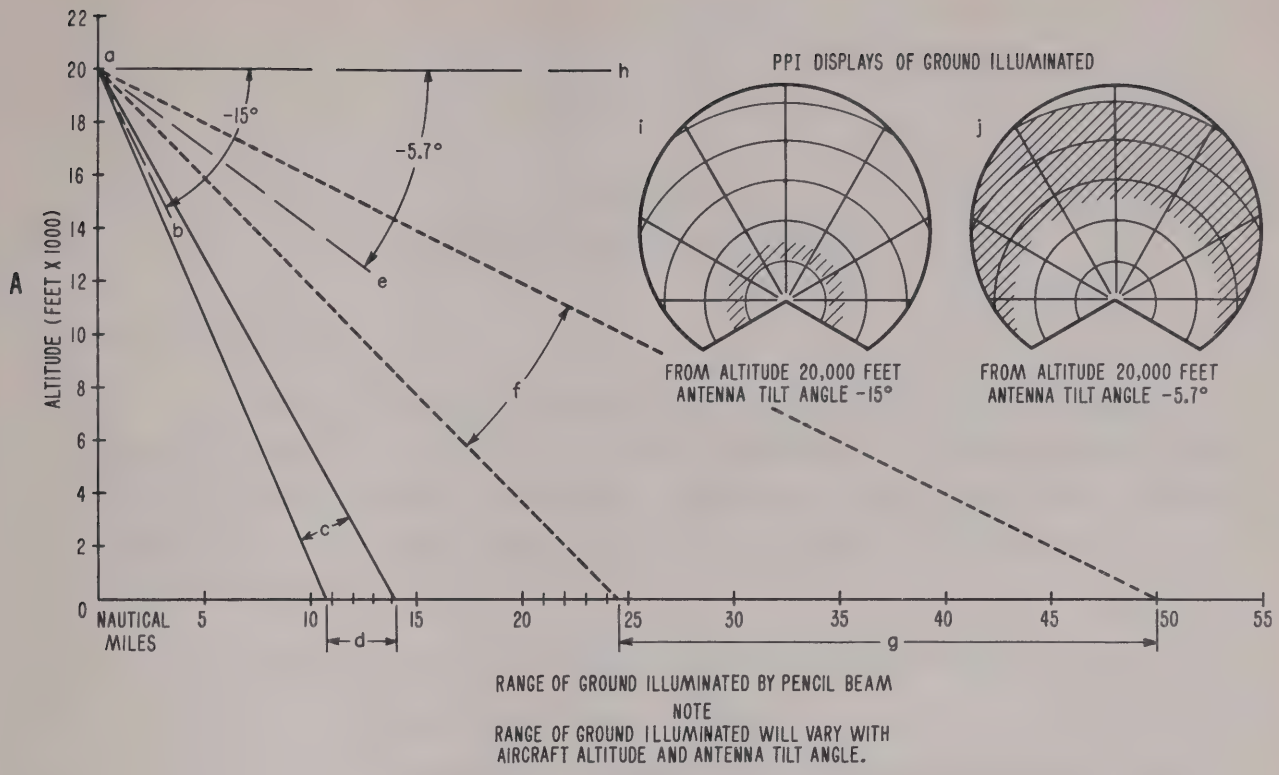
c. Approximate inner cut-off range (five nautical miles)

d. Approximate outer cut-off range (50 nautical miles)

e. Range of ground scanned (5 to 50 nautical miles, approximately)

f. Plane of flight path

g. PPI display of ground area scanned (conditions a, b*)


A
ALTITUDE (FEET X 1000)
NAUTICAL MILES
PPI DISPLAYS OF GROUND ILLUMINATED
FROM ALTITUDE 20,000 FEET ANTENNA TILT ANGLE -15°
FROM ALTITUDE 20,000 FEET ANTENNA TILT ANGLE -5.7°
RANGE OF GROUND ILLUMINATED BY PENCIL BEAM
NOTE
RANGE OF GROUND ILLUMINATED WILL VARY WITH AIRCRAFT ALTITUDE AND ANTENNA TILT ANGLE.

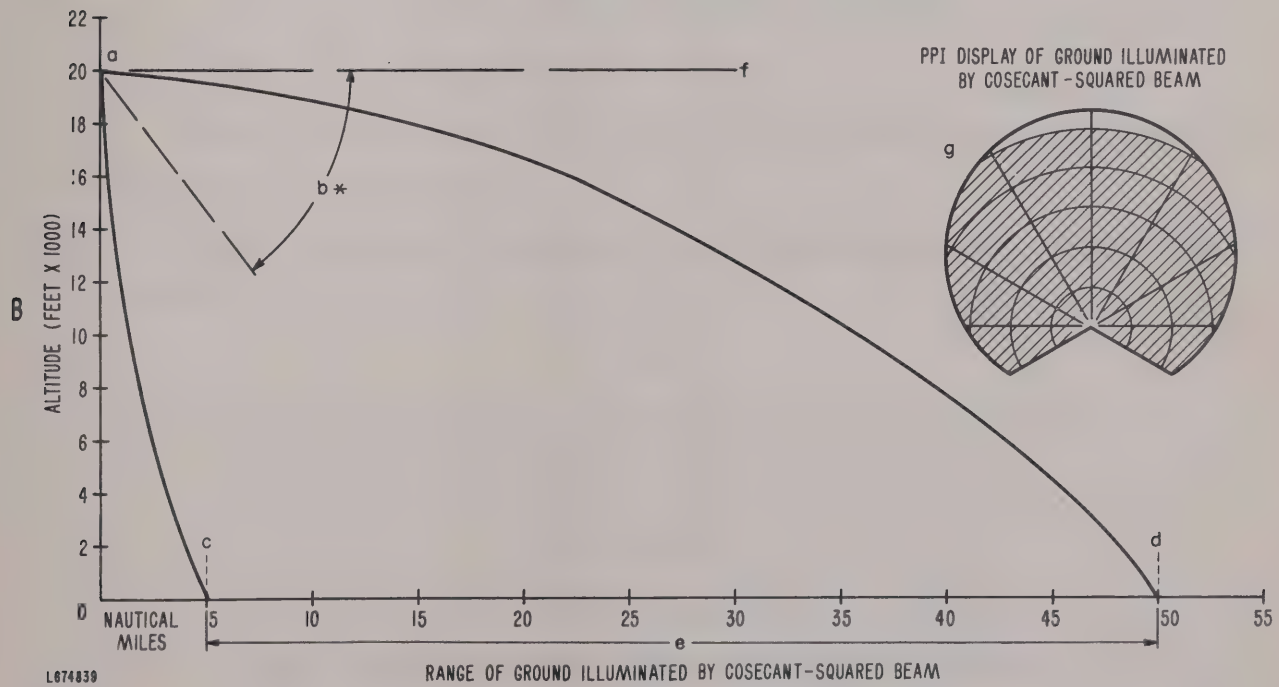


Figure 4-6. Comparison of Pencil-Beam and Cosecant-Squared Beam Coverage

SECTION V
PREVENTIVE MAINTENANCE

5-1. GENERAL.

A schedule of periodic inspections is recommended in the maintenance of the Type RDR-1 Airborne Radar System. Inspections and tests should include frequent operational tests, occasional maintenance inspections of the equipment inside the aircraft, and, after a long operating period, an inspection for overhaul in a maintenance shop.

The inspection and test schedule may be set up somewhat as follows:

BETWEEN-FLIGHTS TEST

400-500 HOUR INSPECTION AND OPERATIONAL TEST

MAJOR OVERHAUL, scheduled to coincide with aircraft's overhaul schedule, if possible

5-2. BETWEEN-FLIGHTS TEST PROCEDURE.

Step 1. With equipment turned OFF, check all units for secure mounting. Tighten where necessary.

Step 2. Make sure all connectors are both mechanically and electrically secure.

NOTE

For the following checks, all primary power sources must be functioning to provide power for the system.

CAUTION

Position aircraft to prevent antenna from scanning any large, close by, metallic surfaces during test. Scanning such surfaces within approximately 150 feet of the antenna may damage receiver crystals.

Step 3. Place the OFF-STBY-ON switch, on the CON-1( ) Control, in the STBY position.

WARNING

Operation of this equipment involves the use of high voltages which are dangerous to life. Operating personnel should at all times observe all safety precautions.

Step 4. Check the operation of unit ventilating blowers, in the RDR-1( ) Transmitter-Receiver and in the SYN-1B Synchronizer-Amplifier-Power Supply.

Step 5. Momentarily switch system to OFF and check, by listening, that unit blowers are turning free and quiet.

Step 6. Place the meter circuit selector switch, on the SYN-1B Synchronizer-Amplifier-Power Supply, in the -250 position. Check that panel meter reads half-scale, indicating the presence of bias voltage. Wait at least three minutes before proceeding with step 7.

Step 7. Place the OFF-STBY-ON switch in the ON position.

Step 8. Place the meter circuit selector switch, on the SYN-1B Synchronizer-Amplifier-Power Supply, in the +300, +260, and +140 positions and check that panel meter reads half-scale for each position of the switch indicating the presence of the several B+ voltages.

Step 9. Turn the GAIN control, on the CON-1( ) Control, fully counterclockwise.

Step 10. Rotate BRILLIANCE control, on the PPI-1( ) Indicator, to provide visible sweep trace on indicator.

Step 11. Check for clockwise rotation of sweep trace indicating antenna rotation.

Step 12. Place the METER CIRCUIT SELECTOR switch, on the RDR-1B-1 Transmitter-Receiver, successively in the MAG, DIR-SIG, REV-SIG, and AFC positions.

Step 13. Check PANEL METER, on the RDR-1B-1 Transmitter-Receiver, for approximately half-scale reading, with needle steady, for each position of switch, indicating transmitter operation and SEARCH AFC lock-in. Note reading in MAG position.

Step 14. Rotate the GAIN control, on the CON-1( ) Control, clockwise to provide target and/or noise displays on the indicator.

Step 15. Increase and decrease receiver gain with GAIN control and observe increase and decrease in brilliance of target and/or noise indications.

Step 16. Place BEACON-OFF switch, on the CON-1( ) Control, in the BEACON position.

Step 17. Note that all target displays disappear from the indicator.

Step 18. Place METER CIRCUIT SELECTOR switch on the RDR-1B-1 Transmitter-Receiver in BCN (beacon) position and note that meter reads 0.1 ma, or more, with needle steady, indicating operation of BEACON local-oscillator and BEACON AFC lock-in.

Step 19. Place METER CIRCUIT SELECTOR switch in MAG position and note that meter reading increases by about 30 per cent above reading noted in step 13.

Step 20. Place BEACON-OFF switch in OFF position.

Step 21. Rotate ANT-TILT control, on CON-1( ) Control, slowly to both extreme positions of tilt and observe change in target displays indicating operation of antenna tilt.

NOTE

Equipment failing in any one of the preceding steps should be immediately corrected by the replacement of the failing

unit or units or by the repair and adjustment of same as outlined in section VI of the instruction book for the unit at fault.

The above test is designed to determine that the system is in operating condition, but does not indicate the level of operating efficiency.

5-3. 400-500 HOUR INSPECTION AND OPERATIONAL TEST PROCEDURE.

The following in-plane inspection is recommended between overhauls, after 400 to 500 hours of operation, to determine the condition of the waveguide installation in the aircraft and the over-all operating level of the radar.

Step 1. Check mounting of waveguide installation and tighten mountings wherever loose or vibrating.

Step 2. Check flexible waveguide sections for wear or other damage. Replace as necessary.

Step 3. Check rigid waveguide sections of installation for dents or other physical damage. Replace dented or otherwise damaged sections.

Step 4. Check all waveguide joints for secure, airtight connections. Tighten where necessary and replace any damaged gaskets.

Step 5. Measure power output of transmitter at the directional coupler connector on the front panel of the RDR-1B-1 Transmitter-Receiver.

Step 6. Measure receiver sensitivity by inserting a test signal at the directional coupler connector on the front panel of the RDR-1B-1 Transmitter-Receiver.

Step 7. Proceed with BETWEEN-FLIGHTS TEST PROCEDURE as outlined in paragraph 5-2. Then proceed with step 8 below.

Step 8. Turn GAIN control on the CON-1( ) Control fully counterclockwise. Check the speed of sweep-trace rotation on the indicator. Sweep trace should rotate clockwise at an even speed between 12 and 18 rpm. Sweep trace should rotate without jerkiness and should produce even illumination over entire portion of display without blank segments appearing.

NOTE

Equipment found faulty in any of the preceding tests should be immediately corrected by the replacement of the faulty unit or units, or by the repair and adjustment of same according to the maintenance instructions given in the instruction book for each major component.

5-4. MAJOR OVERHAUL PROCEDURE.

No fixed time schedule for the complete overhaul of the RDR-1 Airborne Radar System is suggested. The equipment design anticipates 2000 hours of operation without major overhaul. Since all major components of the radar system must be removed from the aircraft for major overhaul, simultaneous overhaul of the radar system and of the aircraft would be advantageous. Therefore, it is recommended that overhaul of the radar system be planned to coincide with the aircraft's overhaul schedule.

Follow the procedures outlined in section VI of the instruction book for each major component to accomplish overhaul, test, and alignment.

After all units of the system have been serviced, test the entire system, operationally, in a bench test setup. Then reinstall the entire system in aircraft and perform TEST OF INSTALLATION as outlined in section III paragraph 3-4 of this handbook.

SECTION VI
CORRECTIVE MAINTENANCE

6-1. GENERAL.

Maintenance procedures for the several major components of the Type RDR-1 (X-band) Airborne Radar System are contained in the instruction book for each major component type. A list of the applicable instruction books appears in section I, paragraph 1-1 of this handbook.

A practical bench test setup for the complete radar system is included in the RDR-1B-1 Transmitter-Receiver instruction book, I. B. -737.

6-2. SERVICE PROBLEMS.

If any unusual or special service problems arise, it is suggested that the Service Department, Bendix Radio, Division of Bendix Aviation Corporation, Towson 4, Maryland, be contacted for advice or assistance.

If it is necessary to ship units to the factory or between operating points, a substantial case made of plywood or equivalently strong material, with strong braces and felt padding, should be provided.

No equipments should be returned to the factory until a Return Authorization (RA) Form is received from the Service Department of Bendix Radio.

SECTION VII
SUPPLEMENTARY DATA AND MODIFICATIONS

7-1. GENERAL.

The data presented in this section includes information relative to the differences in models of various major components of the Type RDR-1 (X-band) Airborne Radar System.

Table 7-1 lists the available models of each major component and explains the differences where more than one model is available.

TABLE 7-1. MAJOR COMPONENT TYPES FOR RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM

TYPE	UNIT NAME	REMARKS
CON-1D	Control	Remote control unit.
CON-1K	Conversion Kit	Kit of parts to be used instead of CON-1D where mounting space is a factor. Requires one additional spst toggle switch, and one dpdt toggle switch with a neutral center position, to complete necessary controls.
RDR-1B-1	Transmitter-Receiver	One model only.
SHK-1A	Shockmount (For RDR-1B-1)	Includes electrical connector and spring-loaded waveguide adaptor.
SHK-1E	Shockmount (For RDR-1B-1)	Electrical connector not supplied. Rear panel height is reduced to allow direct connection of air exhaust tube to RDR-1B-1 air exhaust port. (See figure 7-1.)
SYN-1B	Synchronizer-Amplifier-Power Supply	One model only.
SHK-1D	Shockmount (For SYN-1B)	Standard mount. Includes quick-disconnect electrical connector.
SHK-1F	Shockmount (For SYN-1B)	Features back plate with shroud attached for connection of air exhaust tube. (See figure 7-2.) Includes electrical connector.

TABLE 7-1. MAJOR COMPONENT TYPES FOR RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM (Continued)

TYPE	UNIT NAME	REMARKS
PPI-1B	Indicator	Has electrical connector on pendant cable. Reduces space required to rear of unit. (See figure 7-3.)
PPI-1D	Indicator	Two connectors mounted on rear cover. Video input connector is separate from common electrical connector. (See figure 7-4.)
ANT-1B	Antenna	22-inch reflector.
ANT-1E	Antenna	30-inch reflector.

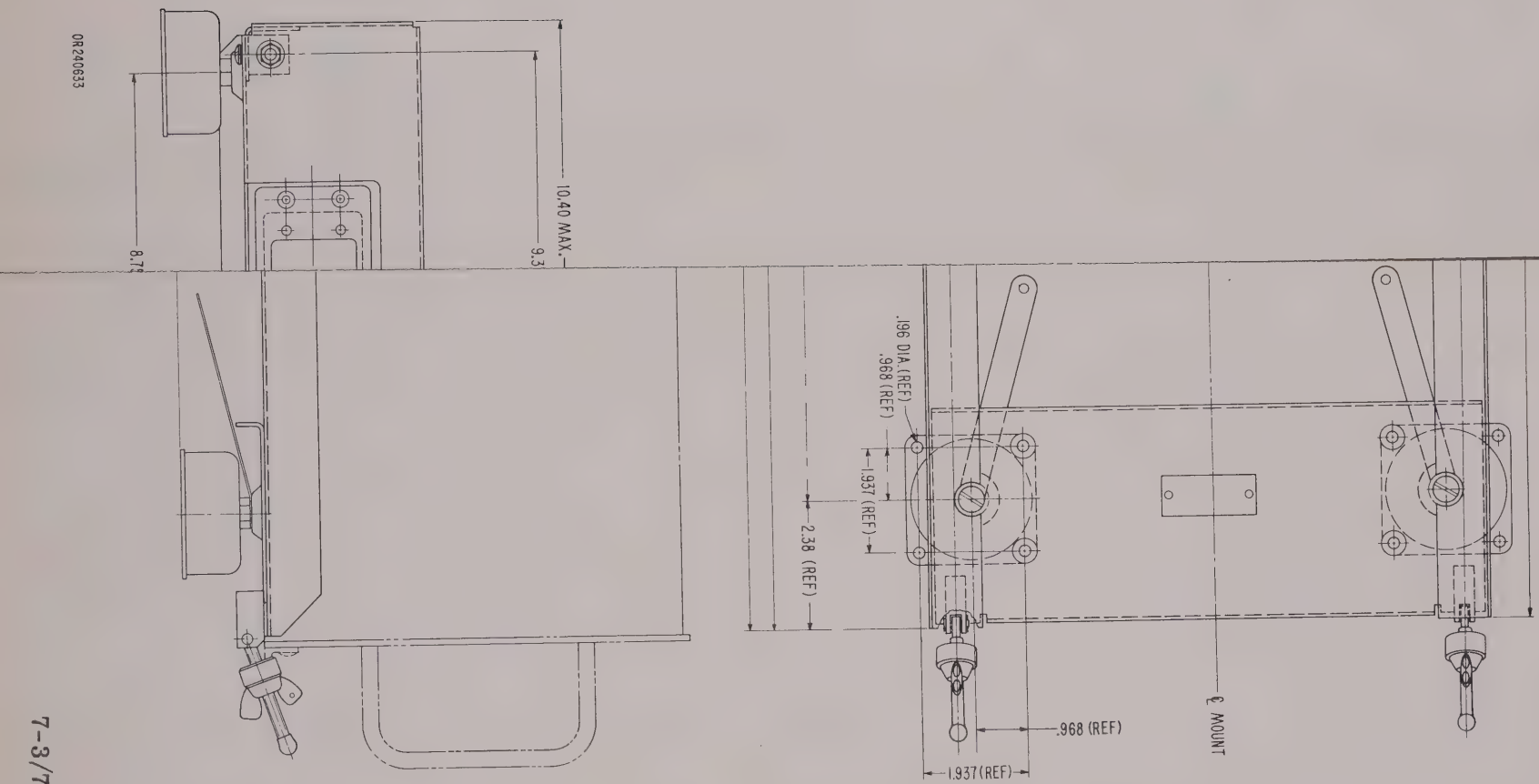


Figure 7-1. SHK-1E Shockmount, Alternate Mount for RDR-1B-1 Transmitter-Receiver, Dimensional Outline Drawing

TABLE 7-1. MAJOR COMPONENT TYPES FOR RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM (Continued)

TYPE	UNIT NAME	REMARKS
PPI-1B	Indicator	Has electrical connector on pendant cable. Reduces space required to rear of unit. (See figure 7-3.)
PPI-1D	Indicator	Two connectors mounted on rear cover. Video input connector is separate from common electrical connector. (See figure 7-4.)
ANT-1B	Antenna	22-inch reflector.
ANT-1E	Antenna	30-inch reflector.

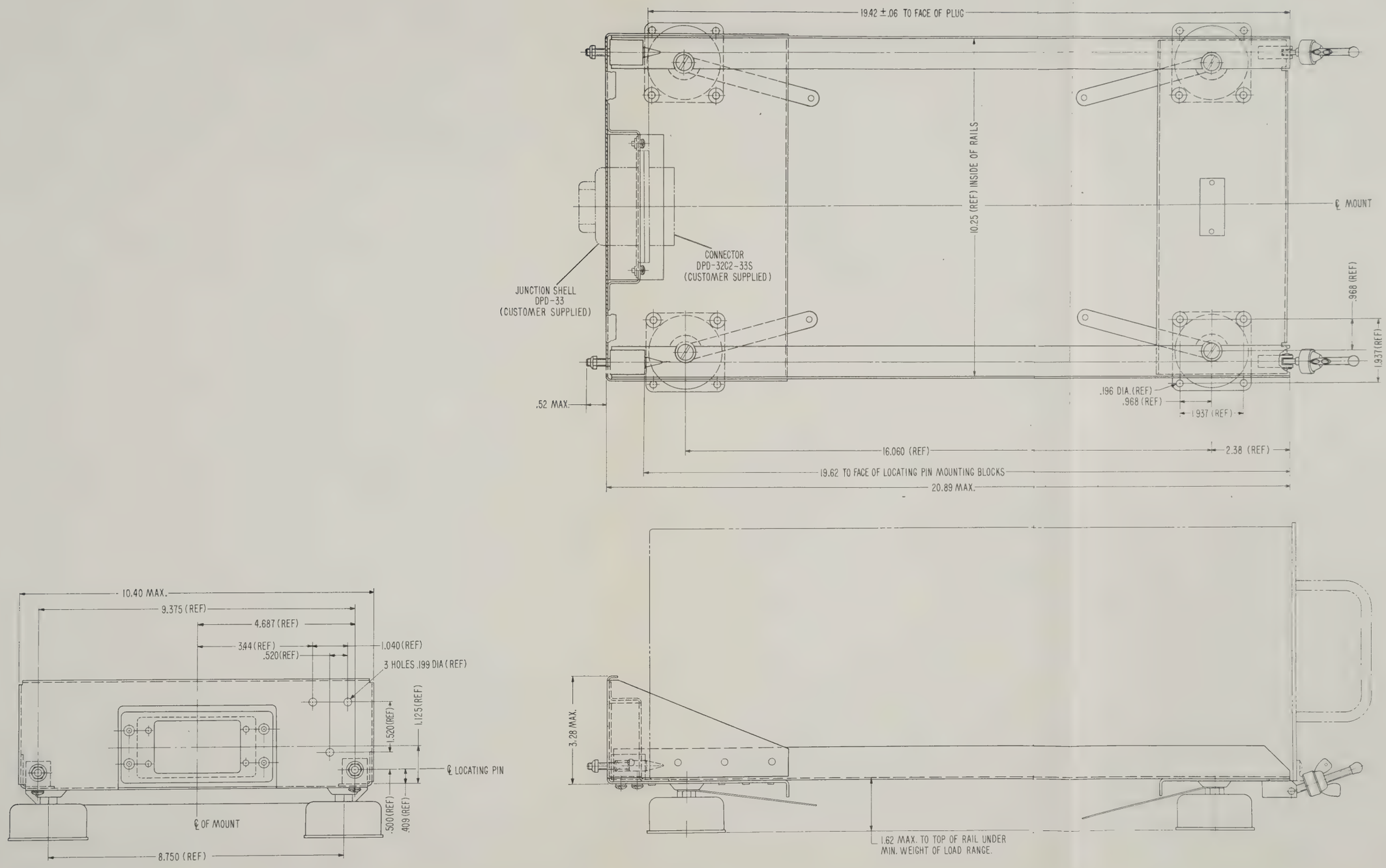


Figure 7-1. SHK-1E Shockmount, Alternate Mount for RDR-1B-1 Transmitter-Receiver, Dimensional Outline Drawing

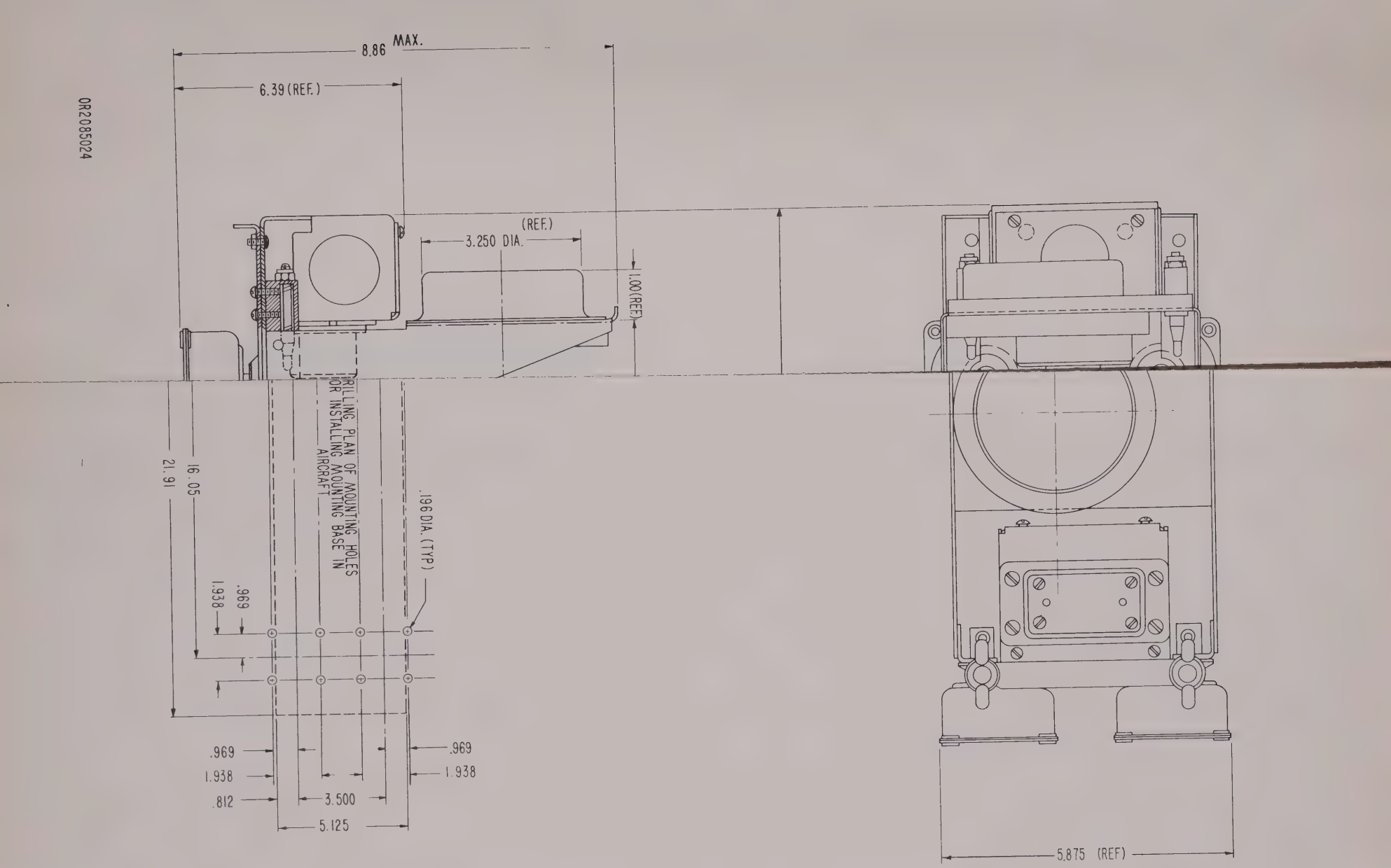


Figure 7-2. SHK-1F Shockmount, Alternate Mount for SYN-1B Synchronizer-Amplifier-Power Supply, Dimensional Outline Drawing

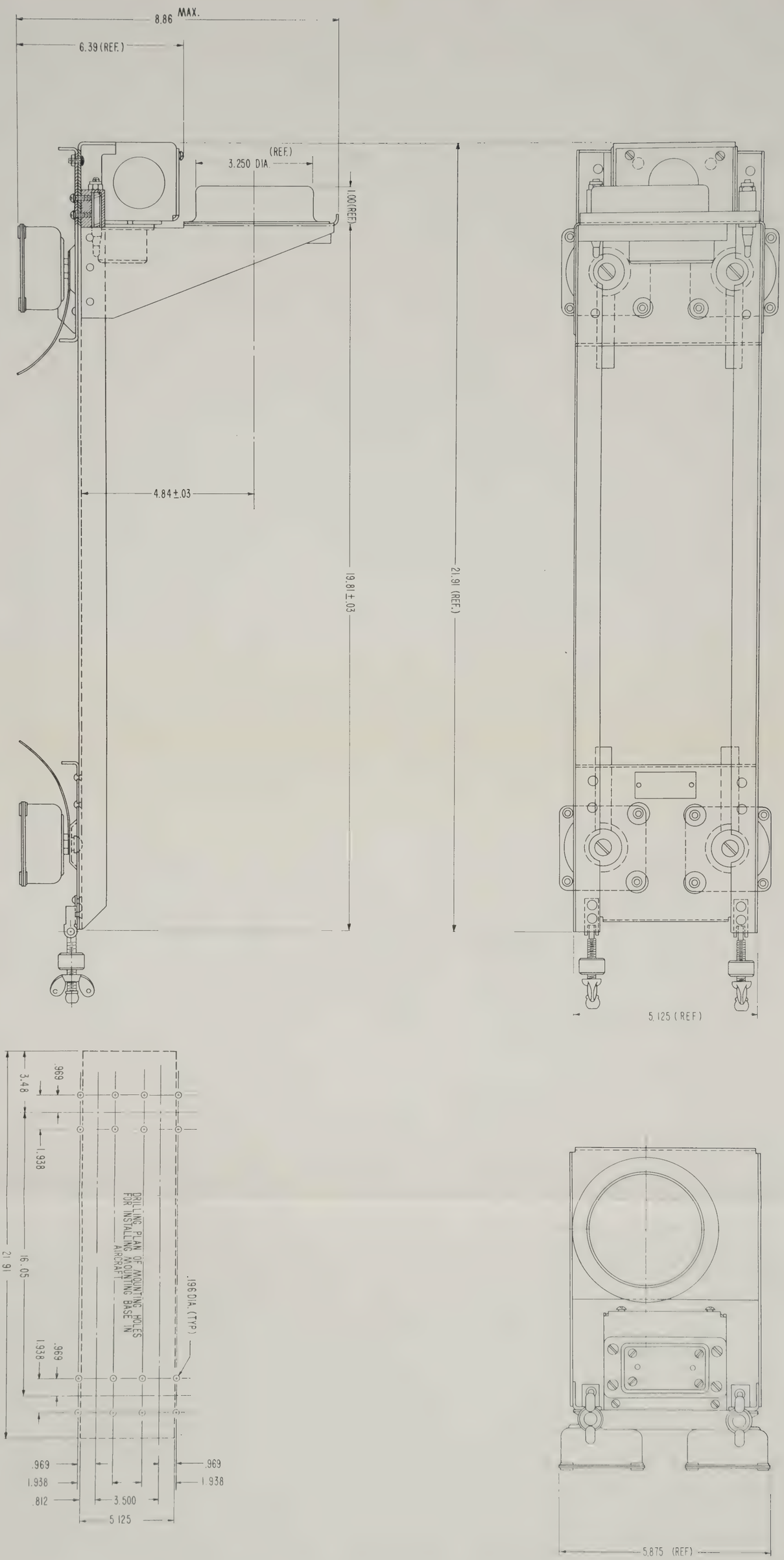


Figure 7-2. SHK-1F Shockmount, Alternate Mount for SYN-1B Synchronizer-Amplifier-Power Supply, Dimensional Outline Drawing

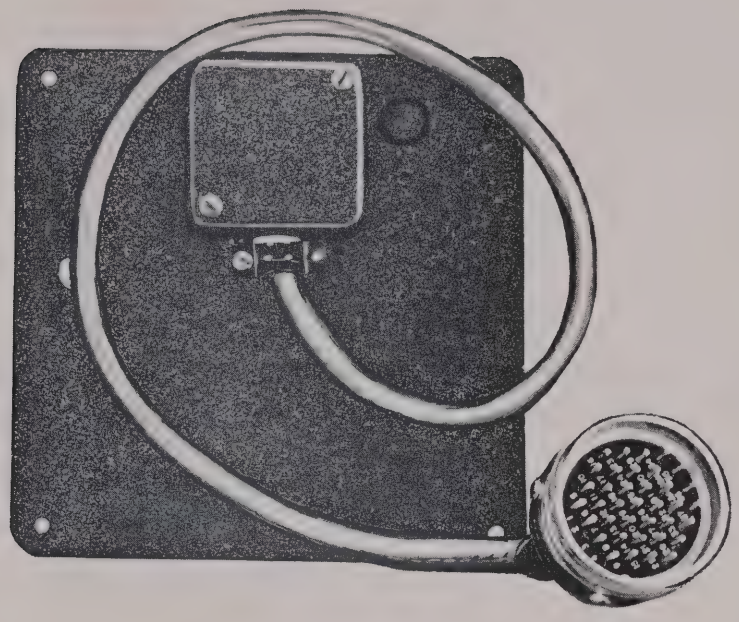


Figure 7-3. PPI-1B Indicator, View of Back Cover

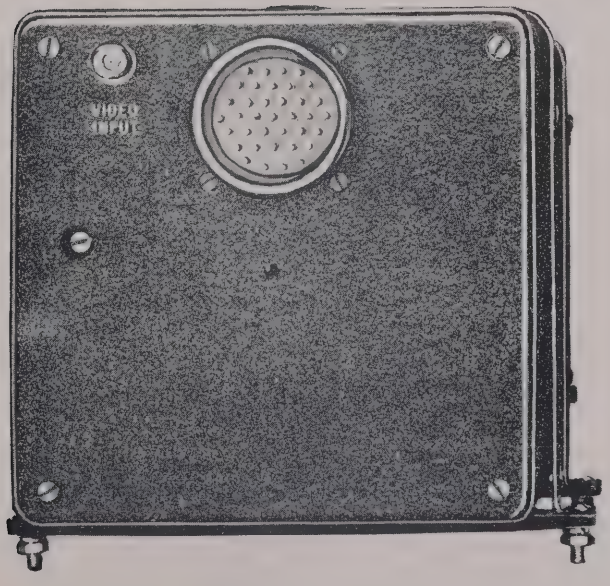


Figure 7-4. PPI-1D Indicator, View of Back Cover

SECTION VIII

PARTS LIST
(ELECTRICAL)
RDR-1 (X-BAND) AIRBORNE RADAR SYSTEM

The electrical parts lists, usually incorporated in this section, are included in the instruction books for the individual major components of the system as listed in section I, paragraph 1-1 of this handbook.

SECTION IX
ILLUSTRATIONS

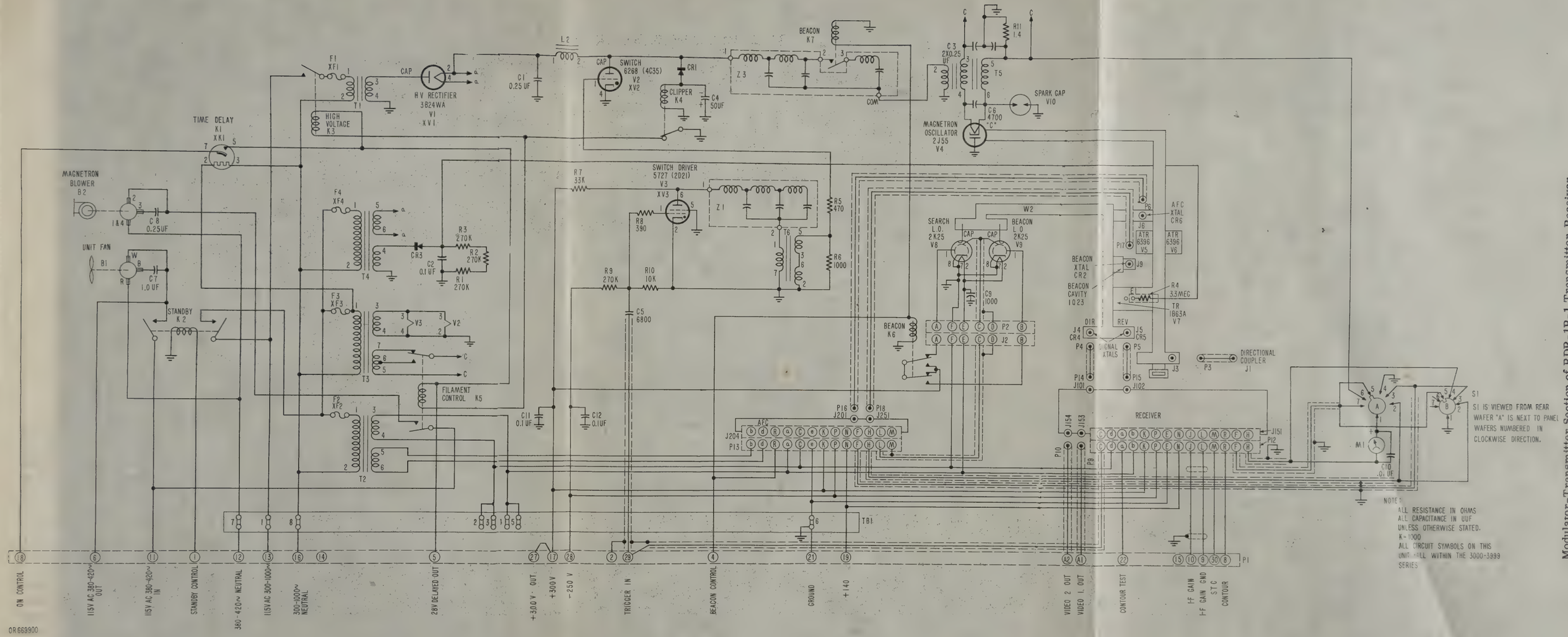
This section contains reproducible, vellum copies of all diagrams listed below. Each copy is perforated along its binding edge for easy removal.

A.	SCHEMATIC DIAGRAMS	DRAWING NUMBER
	1. RDR-1B-1 Transmitter-Receiver, Transmitter-Modulator Section	OR669900
	2. RDR-1B-1 Transmitter-Receiver, Receiver Section	OR669903
	3. RDR-1B-1 Transmitter-Receiver, AFC Section	OR669499
	4. SYN-1B Synchronizer-Amplifier-Power Supply	OR669895
	5. PPI-1B, 1D Indicators	OR669897
	6. ANT-1B, 1E Antennas	N669556
	7. CON-1D Control	OC670677
B.	WIRING DIAGRAM, INTERCONNECTING	
	RDR-1 Airborne Radar System	OR669904

NOTES

NOTES

Modulator-Transmitter Section of RDR-1B-1 Transmitter-Receiver
Part of RDR-1 (X-band) Airborne Radar System, Schematic
Diagram



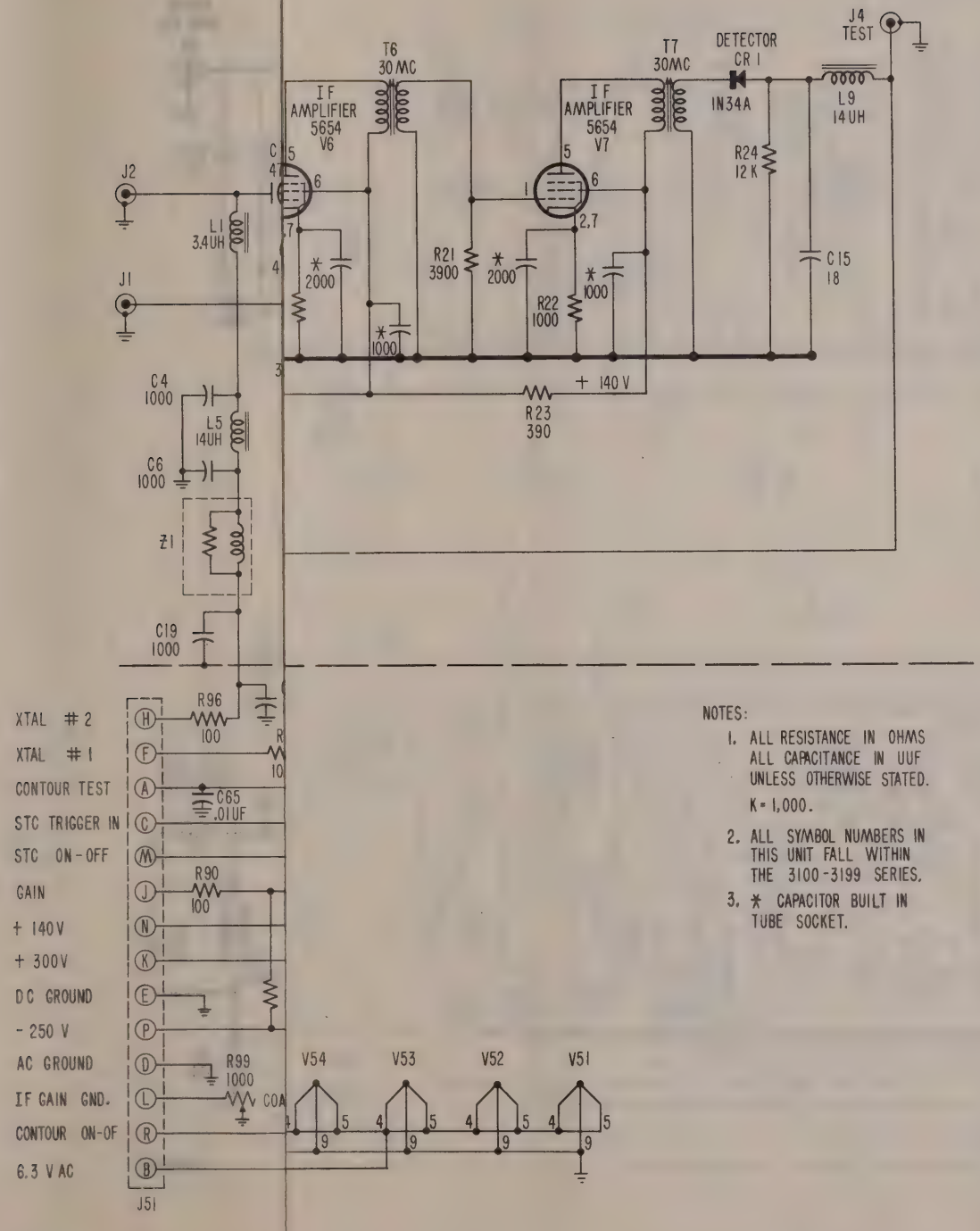
S1 IS VIEWED FROM REAR WAFER "A" IS NEXT TO PANEL WAFERS NUMBERED IN CLOCKWISE DIRECTION.

NOTES:
ALL RESISTANCE IN OHMS
ALL CAPACITANCE IN UUF
UNLESS OTHERWISE STATED.
K-1000
ALL CIRCUIT SYMBOLS ON THIS UNIT WILL WITHIN THE 3000-3999 SERIES

OR 669900

Modulator-Transmitter Section of RDR-1B-1 Transmitter-Receiver
Part of RDR-1 (X-band) Airborne Radar System, Schematic Diagram

HV RECTIFIER
FILAMENT CONTROL
+300 V DC
100 V AC

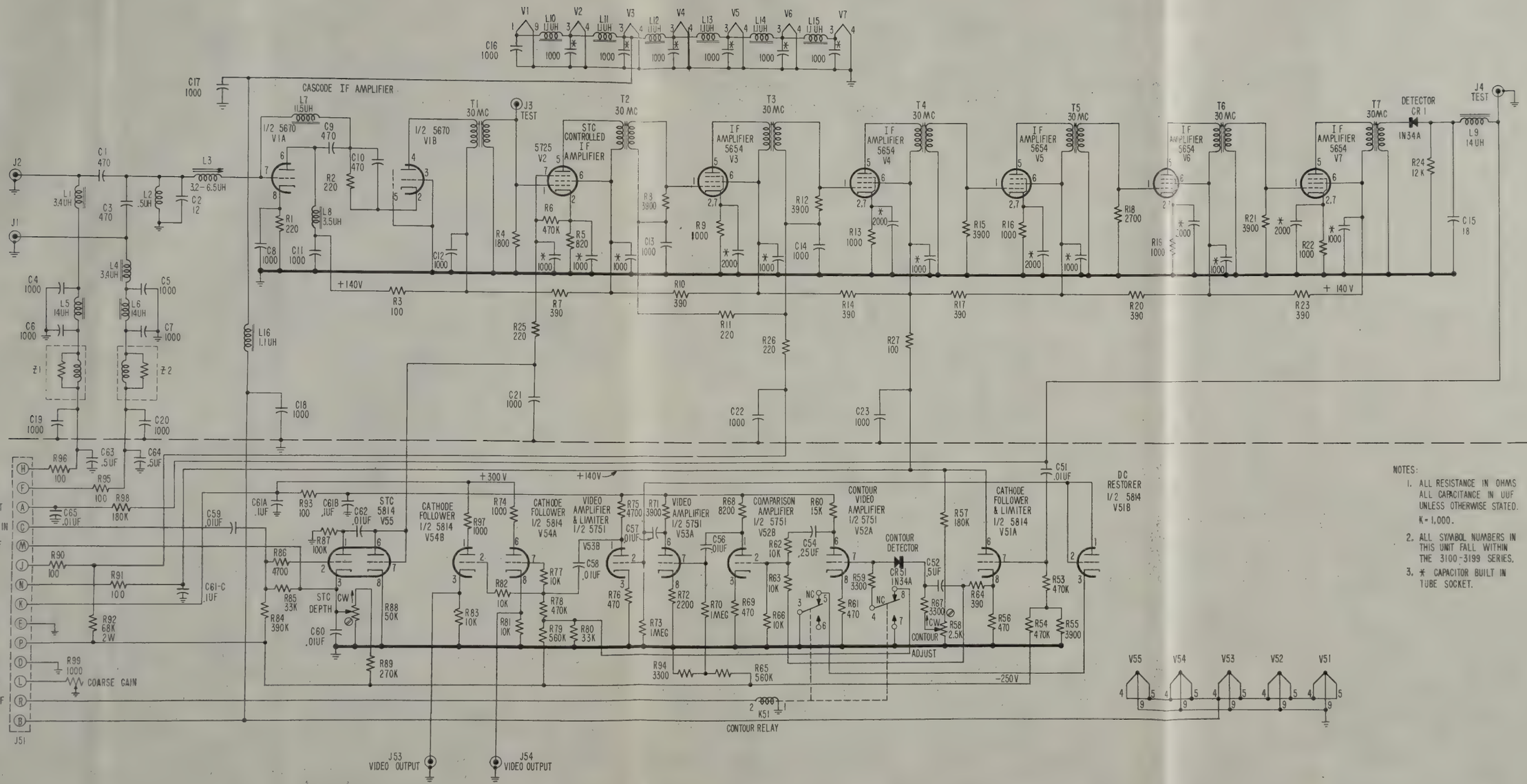


NOTES:

1. ALL RESISTANCE IN OHMS
   ALL CAPACITANCE IN UUF
   UNLESS OTHERWISE STATED.
   K = 1,000.
2. ALL SYMBOL NUMBERS IN THIS UNIT FALL WITHIN THE 3100-3199 SERIES.
3. * CAPACITOR BUILT IN TUBE SOCKET.

OR669903

Receiver Section of RDR-1B-1 Transmitter-Receiver, Part of RDR-1 (X-band) Airborne Radar System, Schematic Diagram

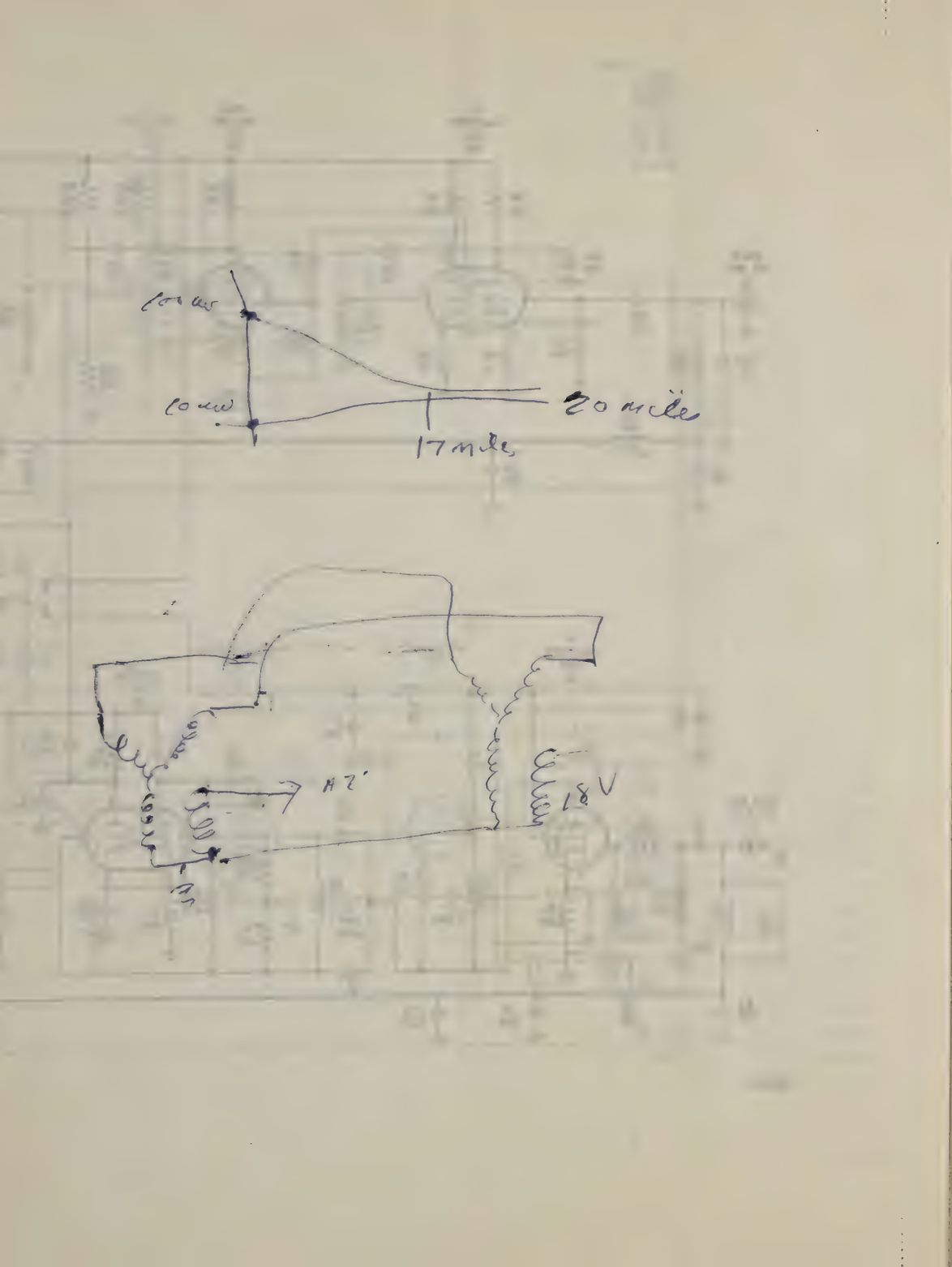


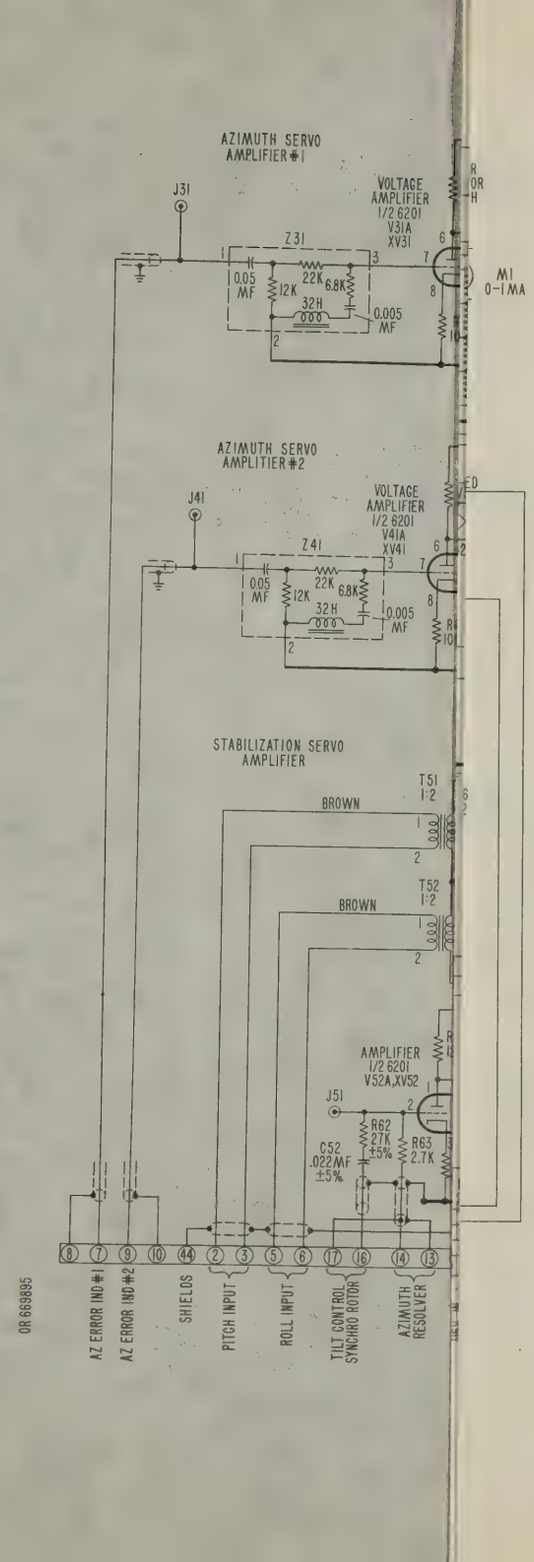
NOTES:

1. ALL RESISTANCE IN OHMS ALL CAPACITANCE IN UUF UNLESS OTHERWISE STATED. K = 1,000.
2. ALL SYMBOL NUMBERS IN THIS UNIT FALL WITHIN THE 3100-3199 SERIES.
3. * CAPACITOR BUILT IN TUBE SOCKET.

OR669903

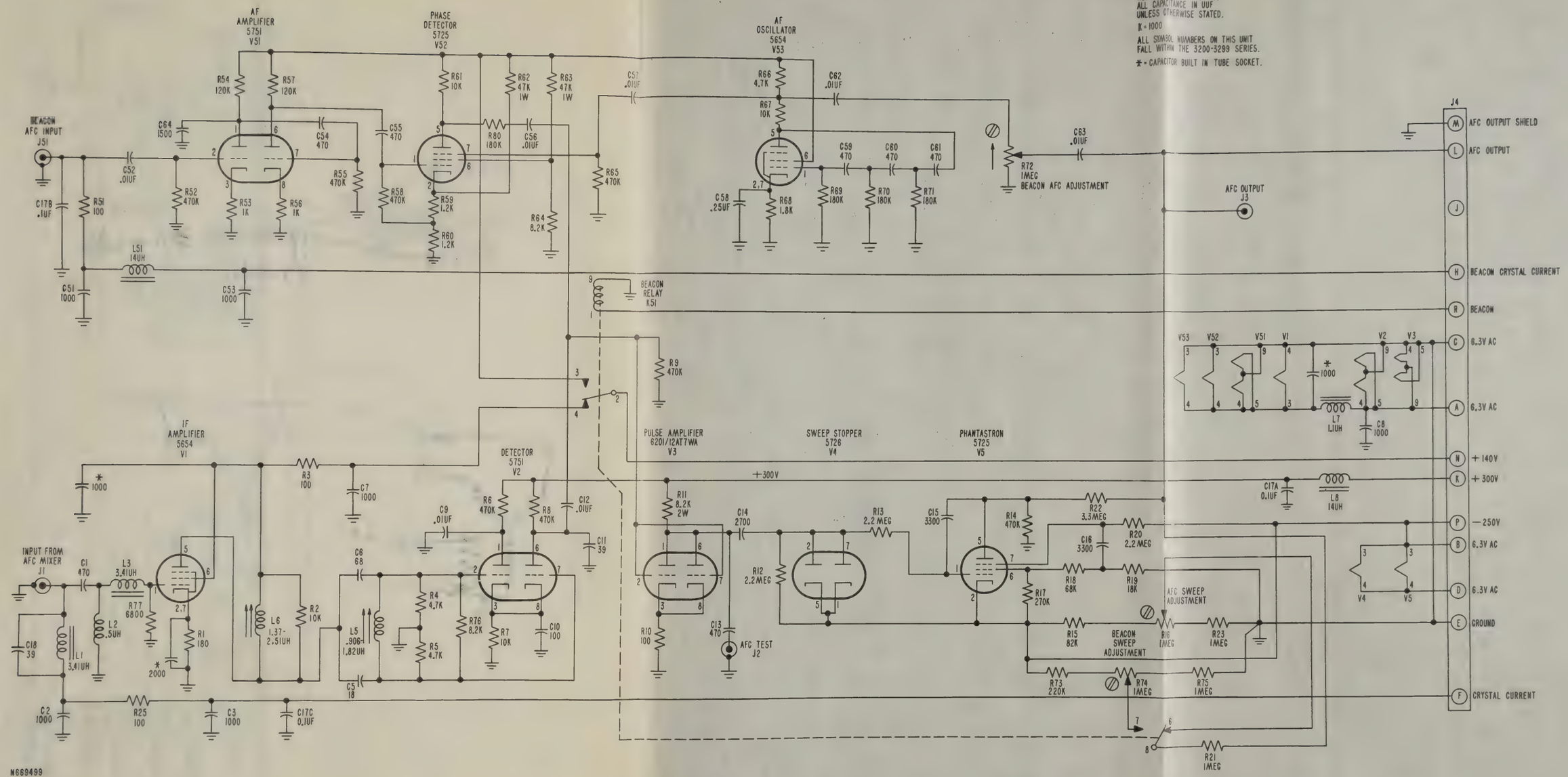
Receiver Section of RDR-1B-1 Transmitter-Receiver, Part of RDR-1 (X-band) Airborne Radar System, Schematic Diagram



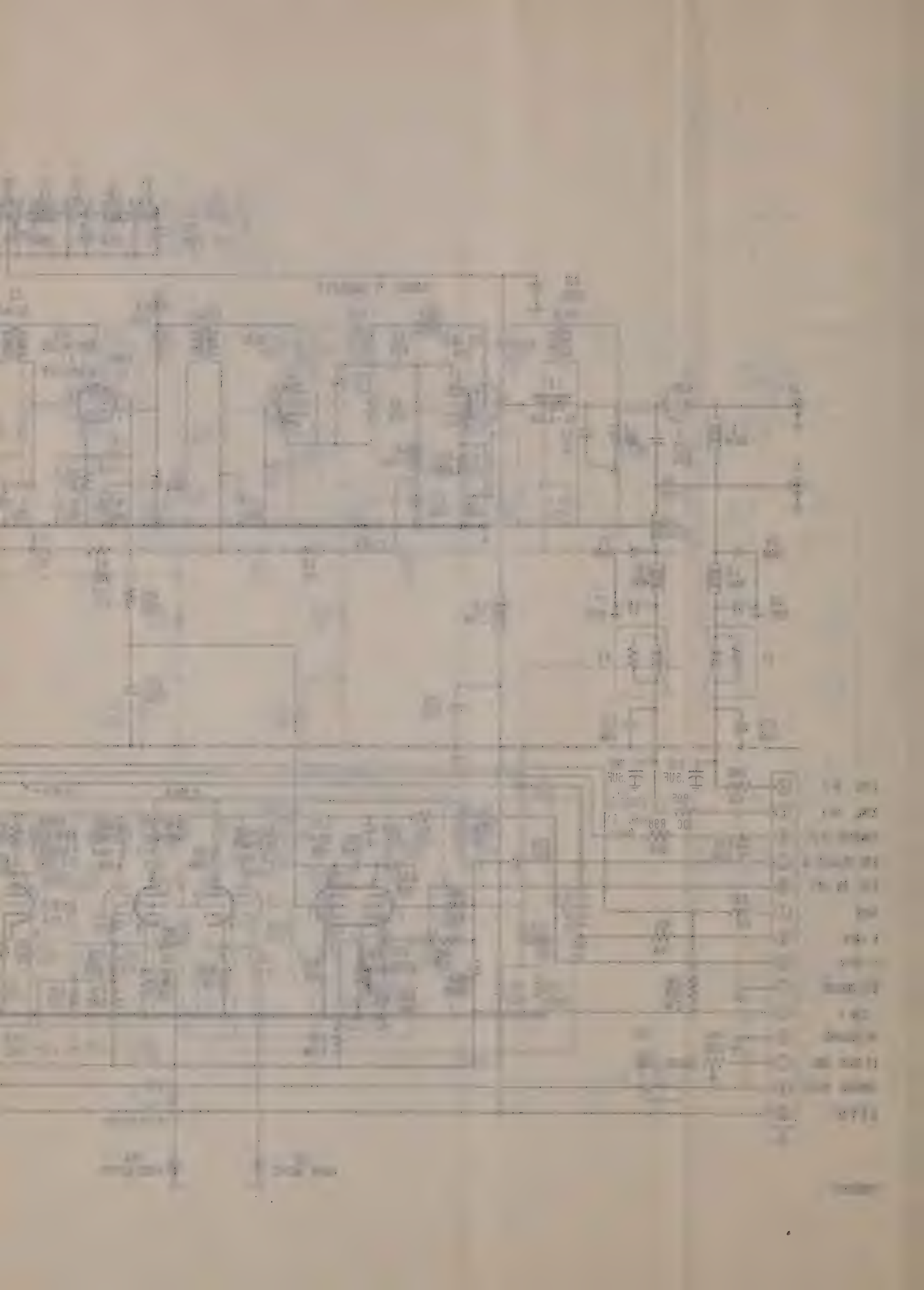


NOTES:
1. ADD 4000 TO ALL CIRCUIT SYMBOL NUMBERS
2. UNLESS OTHERWISE STATED, ALL RESISTANCES ARE IN OHMS; ALL CAPACITANCES ARE IN MICROMICROFARADS.
K = 1000
ALL RESISTORS MUST BE ALLEN BRADLEY'S

SYN-1B Synchronizer-Amplifier-Power Supply, Part of RDR-1
Airborne Radar System, Schematic Diagram

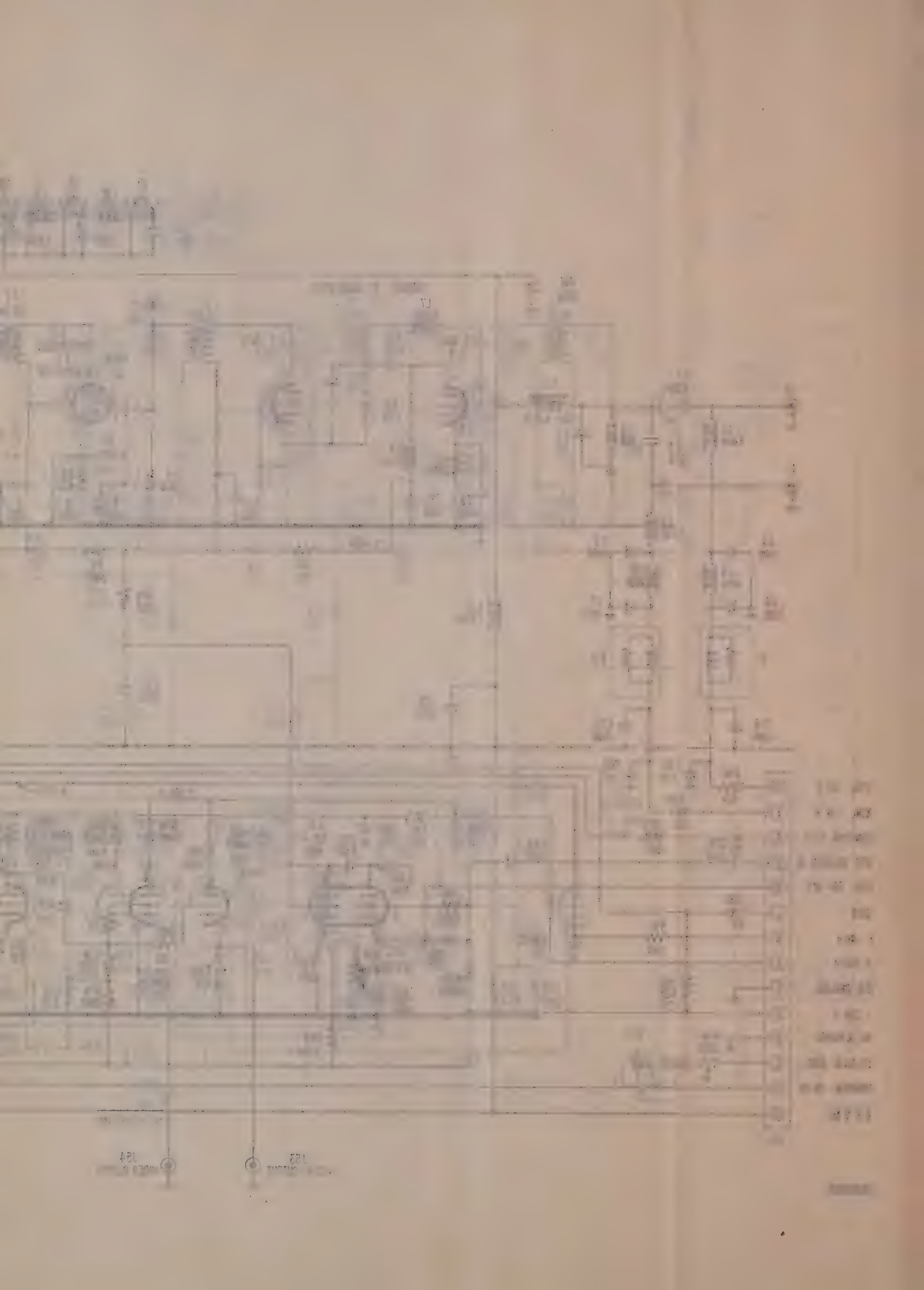


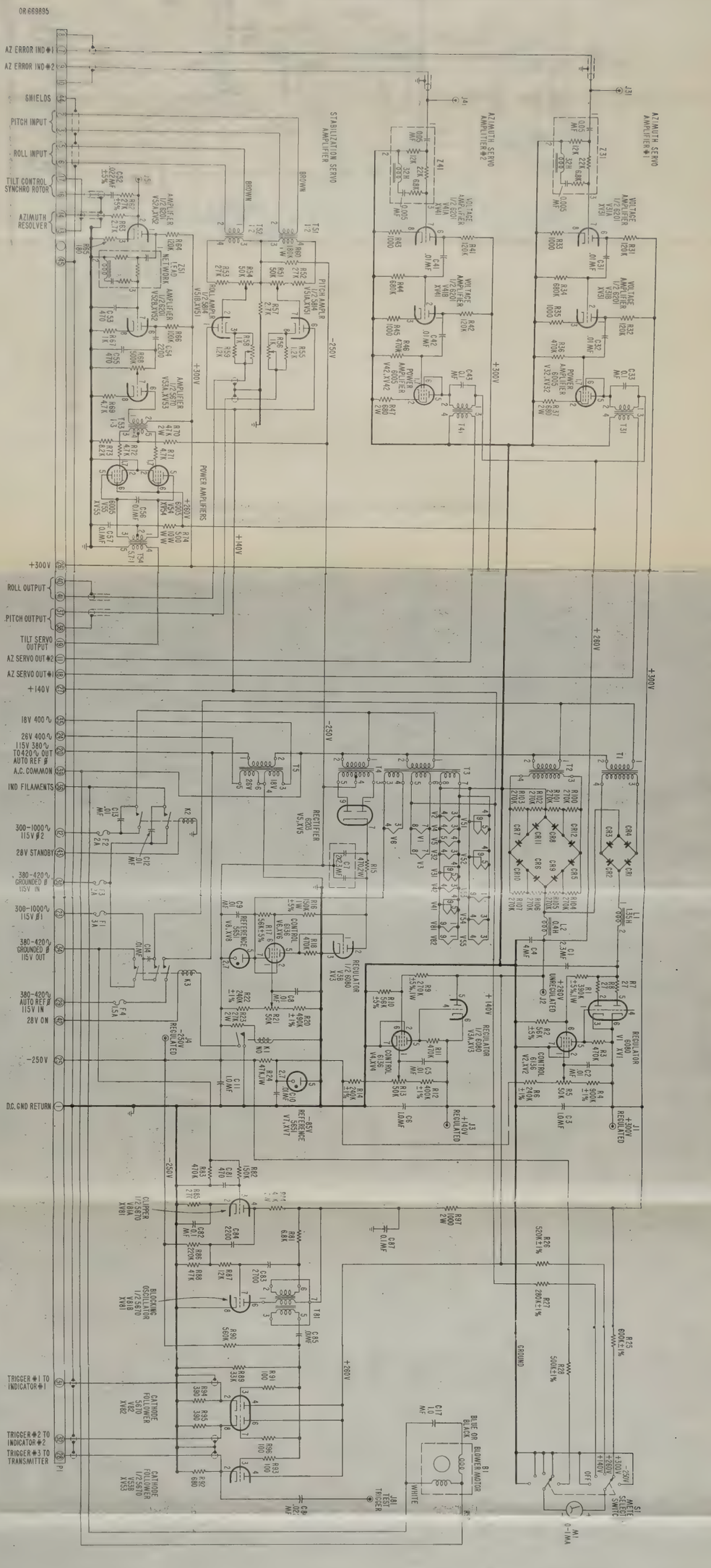
AFC Section of RDR-1B-1 Transmitter-Receiver, Part of RDR-1
(X-band) Airborne Radar System, Schematic Diagram



NOTES:
1. ADD 4000 TO ALL CIRCUIT SYMBOL NUMBERS
2. UNLESS OTHERWISE STATED, ALL RESISTANCES ARE IN OHMS; ALL CAPACITANCES ARE IN MICROMICROFARADS.
   K = 1000
   ALL RESISTORS MUST BE ALLEN BRADLEY'S

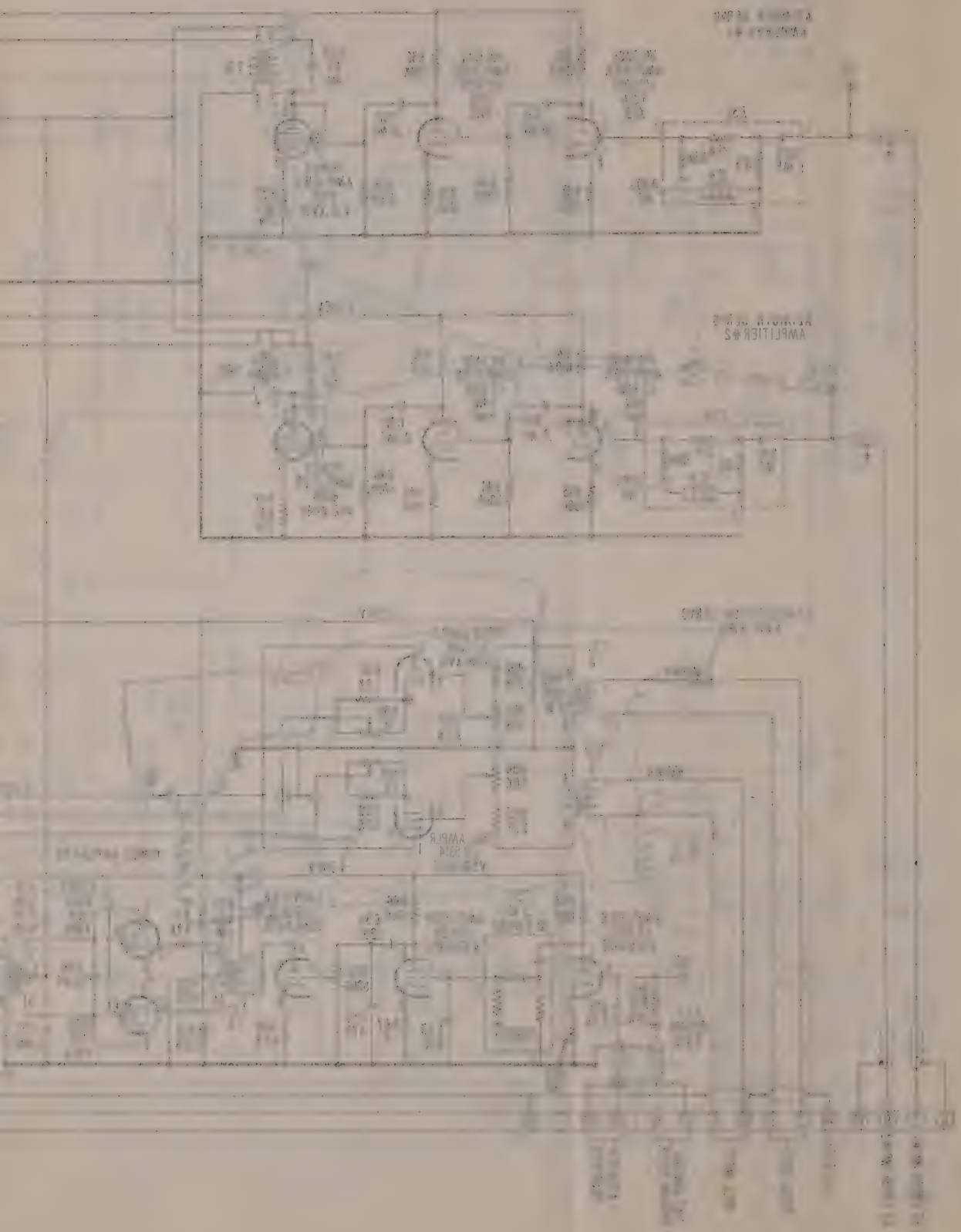
SYN-1B Synchronizer-Amplifier-Power Supply, Part of RDR-1
Airborne Radar System, Schematic Diagram





NOTES
1. ADD 4000 TO ALL CIRCUIT SYMBOL NUMBERS
2. UNLESS OTHERWISE STATED, ALL RESISTANCES ARE IN OHMS AND ALL CAPACITANCES ARE IN MICROMICROFARADS.
K = 1000
ALL RESISTORS MUST BE ALLEN BRADLEY'S

SYN-1B Synchronizer-Amplifier-Power Supply, Part of RDR-1
Airborne Radar System, Schematic Diagram



D.

MH=MILLIHENRY

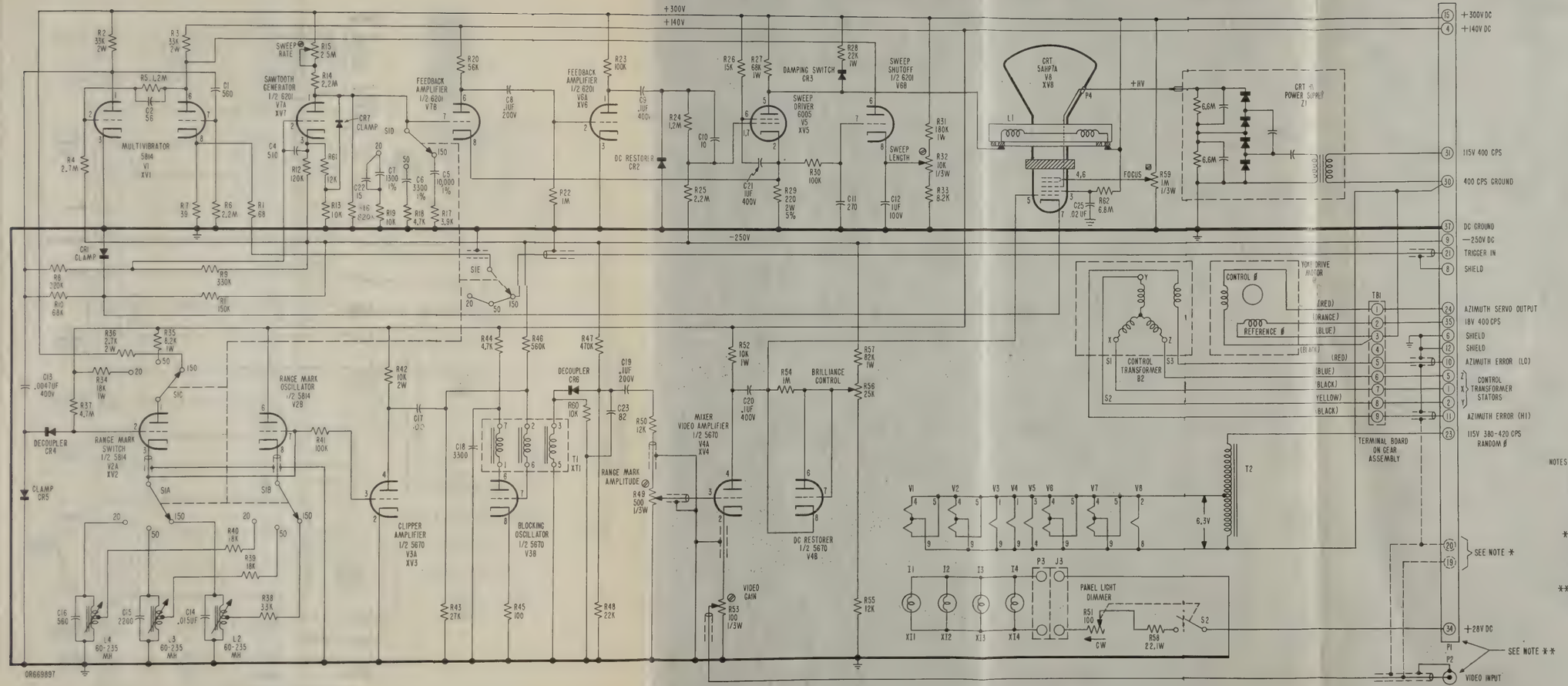
THIS UNIT
RIES.

RS, A FEEDTHRU BOARD REPLACES PI (POWER INPUT CONNECTOR)
NECTOR) ON THE REAR PANEL OF THE UNIT. A SINGLE CONNECTOR
ANT CABLE CONNECTED TO THE FEEDTHRU BOARD TERMINALS.
ONNECTOR PI BECOMES THE VIDEO INPUT AND PIN 20 THE
N IN DASHED LINES. P2 IS ELIMINATED.

RS, PIN 19 AND PIN 20 OF PI ARE NOT USED. PI (POWER INPUT CONNECTOR)
NNECTOR) ARE SEPARATELY MOUNTED ON THE REAR PANEL OF THE

PPI-1B, 1D Indicator, Part of RDR-1 Airborne Radar System, Schematic Diagram

VOLTAGE AMPLIFIER
R31 120K
VOLTAGE AMPLIFIER
AZIMUTH SERVO
R41 120K
VOLTAGE AMPLIFIER
J41
12K
.005 MF
-250V
PITCH AMPLIFIER
STABILIZATION SERVO AMPLIFIER
T51
T52
R57
R69 100K
C54 2200
T51 LEAD NETWORK
R64 120K
AMPLIFIER



NOTES:

ALL RESISTANCE IN OHMS
ALL CAPACITANCE IN UUF
UNLESS OTHERWISE STATE

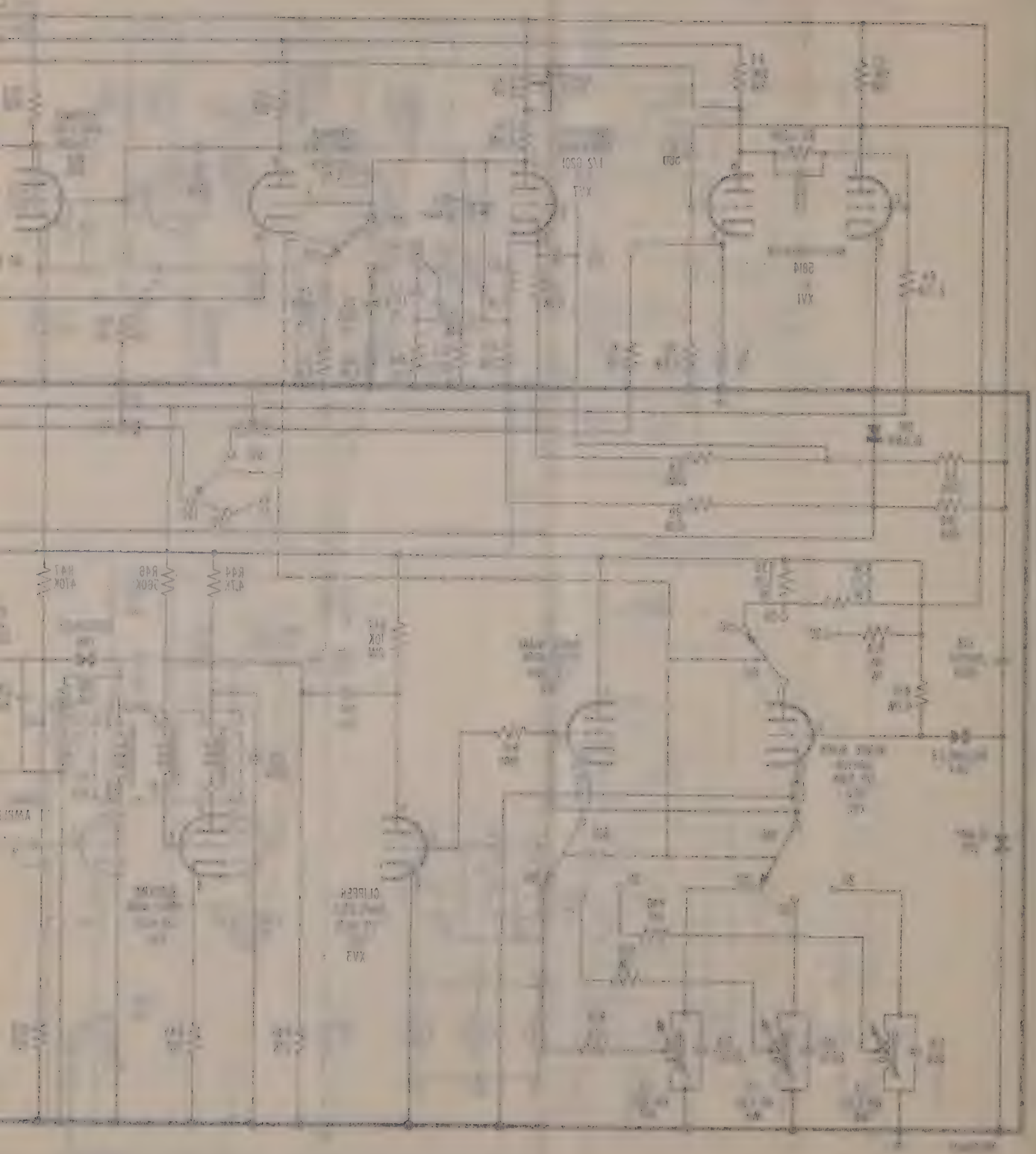
K=1,000 M=1,000,000 MH=MILLIHENRY

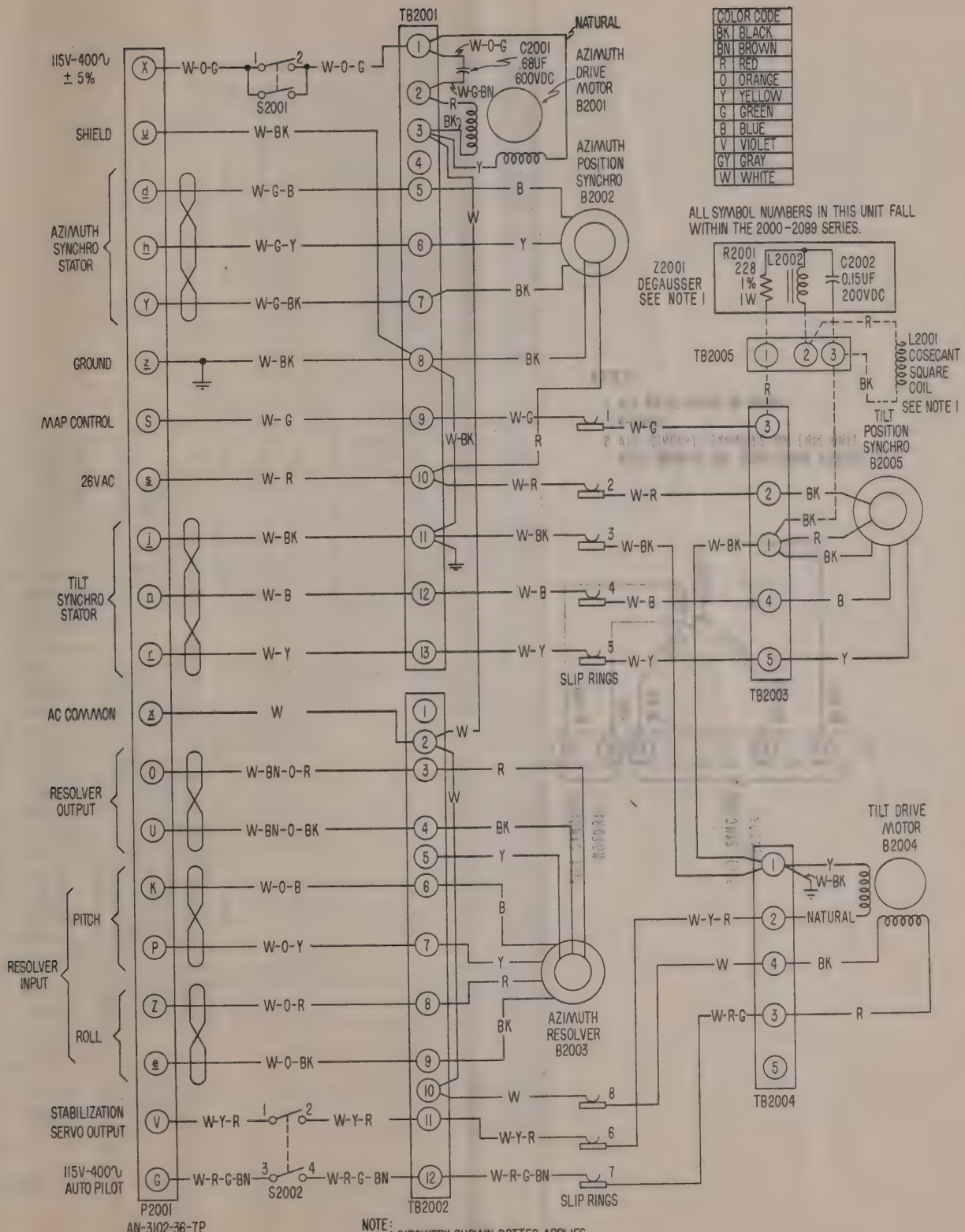
ALL SYMBOL NUMBERS IN THIS UNIT FALL WITHIN THE 1000 SERIES.

* ON TYPE PPI-1B INDICATOR A FEEDTHRU BOARD REPLACES P1 (POWER INPUT CONNECTOR) AND P2 (VIDEO INPUT CONNECTOR) ON THE REAR PANEL OF THE UNIT. A SINGLE CONNECTOR (P1) TERMINATES A PENDANT CABLE CONNECTED TO THE FEEDTHRU BOARD TERMINALS. PIN 19 OF THE PENDANT CONNECTOR P1 BECOMES THE VIDEO INPUT AND PIN 20 THE SHIELD GROUND AS SHOWN IN DASHED LINES. P2 IS ELIMINATED.

** ON TYPE PPI-1D INDICATOR, PIN 19 AND PIN 20 OF P1 ARE NOT USED. P1 (POWER INPUT CONNECTOR) AND P2 (VIDEO INPUT CONNECTOR) ARE SEPARATELY MOUNTED ON THE REAR PANEL OF THE UNIT.

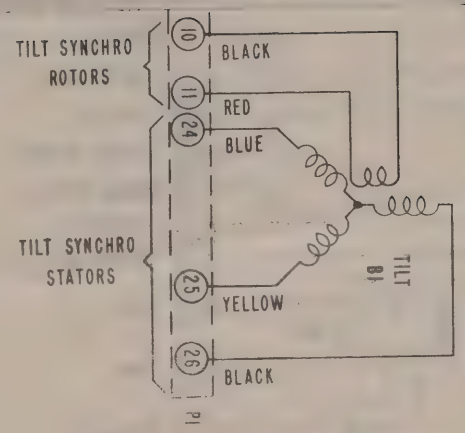
PPI-1B, 1D Indicator, Part of RDR-1 Airborne Radar System, Schematic Diagram





ANT-1( ) Antenna, Part of RDR-1 Airborne Radar System, Schematic Diagram

N669556

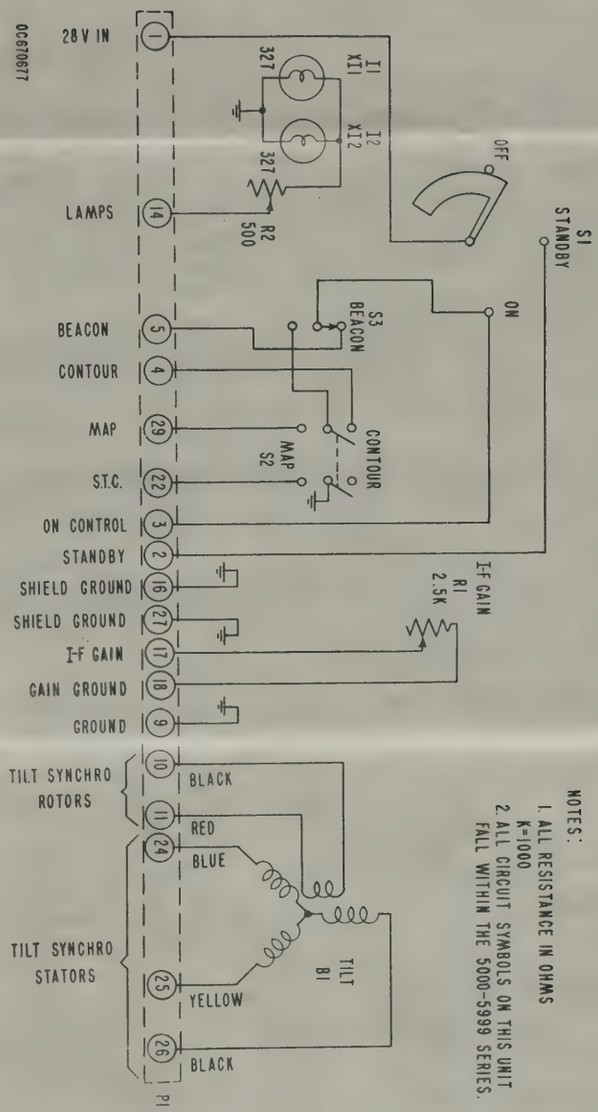


NOTES:
1. ALL RESISTANCE IN OHMS K=1000
2. ALL CIRCUIT SYMBOLS ON THIS UNIT FALL WITHIN THE 5000-5999 SERIES.

CON-1D Control, Part of RDR-1 (X-band) Airborne Radar System, Schematic Diagram

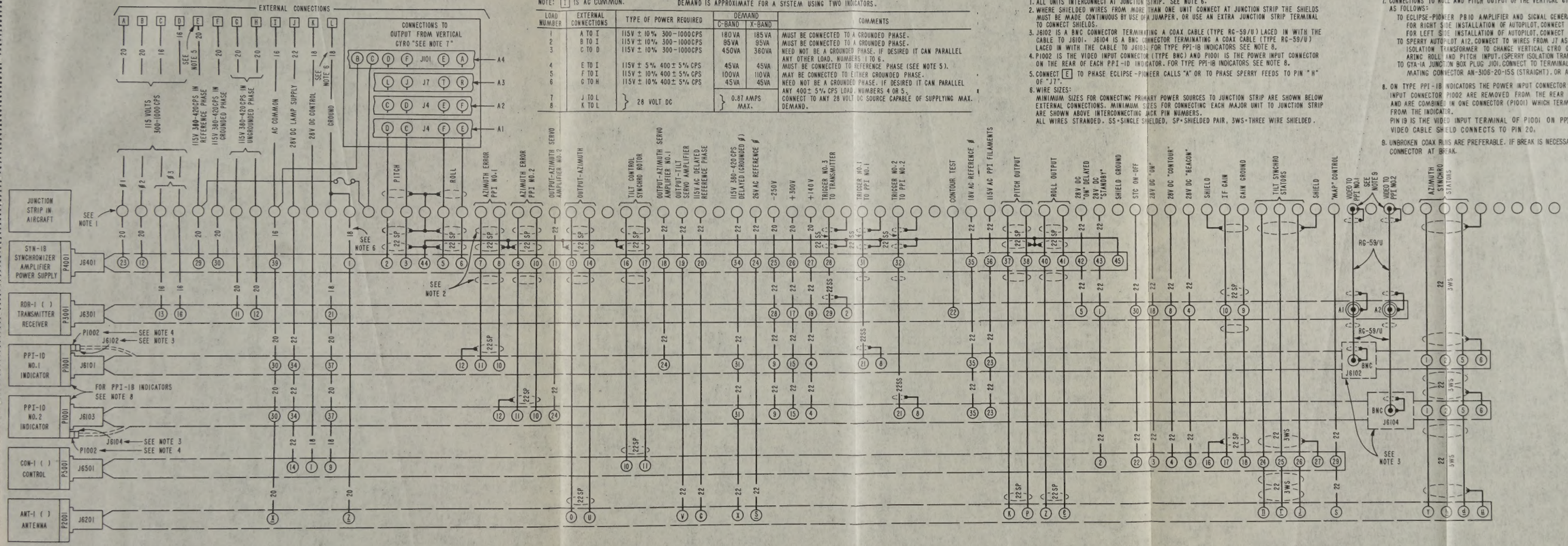
AN/TIH-1( ) Aerospace Ground Equipment, Part of BDR-1 Airborne Heater System

Schematic Diagram



CON-1D Control, Part of RDR-1 (X-band) Airborne Radar System, Schematic Diagram

RDR-1 Airborne Radar System, System Interconnecting Wiring Diagram



INPUT POWER REQUIREMENTS

NOTE: [I] IS AC COMMON. DEMAND IS APPROXIMATE FOR A SYSTEM USING TWO INDICATORS.

LOAD NUMBER	EXTERNAL CONNECTIONS	TYPE OF POWER REQUIRED	DEMAND C-BAND	DEMAND X-BAND	COMMENTS
1	A TO I	115V ± 10% 300-1000CPS	180VA	185VA	MUST BE CONNECTED TO A GROUNDED PHASE.
2	B TO I	115V ± 10% 300-1000CPS	95VA	95VA	MUST BE CONNECTED TO A GROUNDED PHASE.
3	C TO D	115V ± 10% 300-1000CPS	450VA	360VA	NEED NOT BE A GROUNDED PHASE. IF DESIRED IT CAN PARALLEL ANY OTHER LOAD. NUMBERS 1 TO 6.
4	E TO I	115V ± 5% 400 ± 5% CPS	45VA	45VA	MUST BE CONNECTED TO REFERENCE PHASE (SEE NOTE 5).
5	F TO I	115V ± 10% 400 ± 5% CPS	100VA	110VA	MAY BE CONNECTED TO EITHER GROUNDED PHASE.
6	G TO H	115V ± 10% 400 ± 5% CPS	45VA	45VA	NEED NOT BE A GROUNDED PHASE. IF DESIRED IT CAN PARALLEL ANY 400 ± 5% CPS LOAD NUMBERS 4 OR 5.
7	J TO L	28 VOLT DC	0.87 AMPS MAX.		CONNECT TO ANY 28 VOLT DC SOURCE CAPABLE OF SUPPLYING MAX. DEMAND.
8	K TO L	28 VOLT DC			

NOTES:

1. ALL UNITS INTERCONNECT AT JUNCTION STRIP. SEE NOTE 6.
2. WHERE SHIELDED WIRES FROM MORE THAN ONE UNIT CONNECT AT JUNCTION STRIP THE SHIELDS MUST BE MADE CONTINUOUS BY USE OF A JUMPER, OR USE AN EXTRA JUNCTION STRIP TERMINAL TO CONNECT SHIELDS.
3. J6102 IS A BNC CONNECTOR TERMINATING A COAX CABLE (TYPE RG-59/U) LACED IN WITH THE CABLE TO J6101. J6104 IS A BNC CONNECTOR TERMINATING A COAX CABLE (TYPE RG-59/U) LACED IN WITH THE CABLE TO J6101. FOR TYPE PPI-1B INDICATORS SEE NOTE 8.
4. P1002 IS THE VIDEO INPUT CONNECTOR (TYPE BNC) AND P1001 IS THE POWER INPUT CONNECTOR ON THE REAR OF EACH PPI-1D INDICATOR. FOR TYPE PPI-1B INDICATORS SEE NOTE 8.
5. CONNECT [E] TO PHASE ECLIPSE-PIONEER CALLS "A" OR TO PHASE SPERRY FEEDS TO PIN "H" OF "J1".
6. WIRE SIZES:
   MINIMUM SIZES FOR CONNECTING PRIMARY POWER SOURCES TO JUNCTION STRIP ARE SHOWN BELOW EXTERNAL CONNECTIONS. MINIMUM SIZES FOR CONNECTING EACH MAJOR UNIT TO JUNCTION STRIP ARE SHOWN ABOVE INTERCONNECTING JACK PIN NUMBERS.
   ALL WIRES STRANDED. SS=SINGLE SHIELDED, SP=SHIELDED PAIR, 3WS=THREE WIRE SHIELDED.
7. CONNECTIONS TO ROLL AND PITCH OUTPUT OF THE VERTICAL GYRO MUST BE MADE AS FOLLOWS:
   TO ECLIPSE-PIONEER PB10 AMPLIFIER AND SIGNAL GENERATOR PLUG J4;
   FOR RIGHT SIDE INSTALLATION OF AUTOPILOT, CONNECT TO TERMINALS AS IN "A1".
   FOR LEFT SIDE INSTALLATION OF AUTOPILOT, CONNECT TO TERMINALS AS IN "A2".
   TO SPERRY AUTOPILOT A12, CONNECT TO WIRES FROM J7 AS IN "A3" USING PROPER ISOLATION TRANSFORMER TO CHANGE VERTICAL GYRO OUTPUT TO STANDARD ARINC ROLL AND PITCH INPUT. (SPERRY ISOLATION TRANSFORMER NO.6B1T8)
   TO GYA-1A JUNCTION BOX PLUG J101, CONNECT TO TERMINALS AS IN "A4"; USE MATING CONNECTOR AN-3106-20-15S (STRAIGHT), OR AN-3108A-20-15S (ANGLE).
8. ON TYPE PPI-1B INDICATORS THE POWER INPUT CONNECTOR P1001 AND THE VIDEO INPUT CONNECTOR P1002 ARE REMOVED FROM THE REAR OF THE INDICATOR CHASSIS AND ARE COMBINED IN ONE CONNECTOR (P1001) WHICH TERMINATES A PENDANT CABLE FROM THE INDICATOR.
   PIN 19 IS THE VIDEO INPUT TERMINAL OF P1001 ON PPI-1B INDICATORS; THE VIDEO CABLE SHIELD CONNECTS TO PIN 20.
9. UNBROKEN COAX RUNS ARE PREFERABLE. IF BREAK IS NECESSARY USE TYPE BNC CONNECTOR AT BREAK.

RDR-1 Airborne Radar System, System Interconnecting Wiring Diagram

EXTERNAL CONNECTIONS
SEE NOTE 1
SEE NOTE 2
SEE NOTE 3
SEE NOTE 4
SEE NOTE 5
SEE NOTE 6
SEE NOTE 7
SEE NOTE 8
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BENDIX RADIO

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